Source of Energy

Physics – X CBSE

INTRODUCTION

Energy is an essential requirement of our life. No activity in our daily life can be undertaken without the use of energy. Energy in one or the other form has been used by a man sine long. For example, energy is required to undertake the activities like cooking food, heating water, heating rooms, glowing bulbs and tubes in our homes. Energy is also needed to operate radios, televisions, computers washing machines, refrigerators, ovens etc. scooters, buses, trucks, aero plans, ships, motorboats, rockets etc. energy is needed to operate machines in factories to produce goods.

Thus, we can say that energy is required in every field. Usually, energy in the form of fuel and electricity is used to carry out all the activities mentioned above. Energy can be derived from various sources of energy. However, the sun is the ultimate source of all forms of energy.

DIFFERENT SOURCES OF ENERGY

Anything which supplies useful energy to us to carry out the carious activities like cooking, heating, lighting, running buses, cars, trains, scooters, motorcycles, aero planes, ships, operating many devices like TV, radio, tape recorder, computer etc. is known as a source of energy.

There are many sources of energy like plants, wind water, coal petroleum, natural gas or bio-gas etc. However, all these sources of energy deriver energy from the sun.

It is estimated that the sun is about 5 billion years old and continue to shine for another 5 billion years old. So this source of energy will be available to us for a very–very long period of time.

The sun is the ultimate source of all forms of energy available on the earth. This can be illustrated as follows :

Solar energy heats up the surface of the earth and the air around it. The hot air rises up and the cool air from the surroundings rushes to occupy its space. This makes the air to move. Moving air is known as wind and possesses kinetic energy. Thus, solar energy + Air $\rightarrow$ Wind energy.

Green leaves of plants make their food using sunlight (i.e., Sun's energy) by the process of photosynthesis. The energy stored in the food is known as chemical energy. The food eaten by a man or an animal provides him the muscular energy. This muscular energy is used to do work. In other words, muscular energy is converted into mechanical energy. Thus, Solar energy + Green leaves + Food (chemical energy) $\rightarrow$ Muscular energy $\rightarrow$ Mechanical energy (work).

The solar energy evaporates the water in oceans, rivers, lakes and ponds. The evaporated water is converted into clouds (having both kinetic energy and potential energy). These clouds on cooling give rain. The rain water flows through rivers and has kinetic energy. This water is stored in dams and hence possesses potential energy. When this converted into its kinetic energy. The kinetic energy of flowing water rotates the turbine of a generator, the generator in turn produces the hydro electricity or hydro electric power. Thus, hydro electric energy is also derived from the solar energy. Solar energy $+H_2O \rightarrow$ Clouds $(K.E.+P.E.) \rightarrow$ Rain (flowing water, $K.E.) \rightarrow$ Hydro electricity (electric energy).

Even the energy of fossil fuels like coal, petroleum and natural gas also come from the solar energy. Long ago, plants and animals which had derived the energy from the sun in the from of food after their death were buried under the earth. Due to high temperature and the fossil fuels like coal,. Petroleum and natural gas. These fuels store chemical energy which is converted into heat energy when the fuel burns. This heat energy can be converted into mechanical energy with the help of heat engines. Moreover, the heat energy produced by burning the fuel is also used to produce electricity.

WHAT IS A GOOD SOURCE OF ENERGY ?

A good source of energy should have the following characteristics.

(i) It should supply enough amount of useful energy.

(ii) It should b easily stored.
(iii) It should be easily transported.
(iv) It should occupy less space for storage.
(v) Is should supply useful energy in a controlled manner.
(vi) Is should be easily available or accessible.
(vii) It should be cheap i.e., it should be economical.
(viii) It should cause minimum environmental pollution.

In our day –to day life, we usually use fuel and electricity to carry out carious activities. A good fuel has the following characteristics :

(i) It should release large amount of heat energy on burning.
(ii) It should not process much smoke on burning. A good duel either produces very less or no smoke on burning.
(iii) It should be easily available.
(iv) It should be cheap (i.e., economical).

Note : The amount of heat energy produced by a fuel o burning is measured in terms of the calorific value of the fuel.

Calorific value of a fuel is defined as the amount of heat energy released in joule or kilo joule by the complete burning of 1 gram fuel.

(i) Calorific value of a fuel is expressed as joule/gram (Jg^{-1}) or kilo joule/g (kJg^{-1}).

A fuel having high calorific value is a good fuel.

(ii) Calorific value of gaseous fuel is expressed as kilocalorie/metre ^{2} (kcal cm^{-3}).

Calorific values of different fuels are given below in the table 1.

Nature of fuel	Name of fuel	Calorific value $(kJ\ g^{-1})$
Solid Fuels	Animal dung cake	8
	Wood	17
	Charcoal	33
	Coal	35
	Anthracite	37
Liquid Fuels	Alcohol	30
	Diesel	45
	Kerosene oil	48
	Petrol	50
Gaseous fuels	Biogas	35-40
	LPG	55
	Hydrogen	150

CONVENTIONAL (NON–RENEWABLE) SOURCES OF ENERGY

The sources of energy which are exhaustible (i.e., which can be finished) and have been formed in nature long ago are known as conventional sources of energy or non – renewable sources of energy. Fossil fuels are the examples of conventional sources of energy.

FOSSIL FUELS

The combustible substances formed from the dead remains of the animals and plants which were buried deep under the surface of the earth over millions of years are called fossil energy sources or fossil fuels. At present, a major part of our energy requirement is being supplied by fossil fuels.

Examples of fossil fuels : Coal, petroleum and natural gas.

COAL

Coal is a fossil fuel and the major source of energy. It is a black material which is a mixture of carbon and compounds a carbon containing oxygen, nitrogen and sulphur.

USES OF COAL

(i) Coal is used for cooking food and heating water.
(ii) Coal is used in thermal power plants to produces electricity.
(iii) Coal is used by black smiths to melt fold and other metals.
(iv) Coal is used in brick kilns and other industries.

PETROLEUM

Petroleum is derived from two words petra (in Greak) = rock and oleum = oil. Thus, petroleum means rock oil.
Nature and composition of petroleum
Petroleum is general is a mixture of natural hydrocarbons (compounds consisting of carbon and hydrogen) in the form of gas liquid or solid found in rocks. In common use, the liquid from of hydrocarbons is called petroleum. It is a grayish–black viscous liquid.]

REFINING OF PETROLEUM

Petroleum which exists in the rocks of the earth is in a crude state. This crude oil is mixture of gaseous, liquid and solid hydrocarbons. Some of the hydrocarbons are most volatile and some are the least volatile. Thus, various hydrocarbons present in the petroleum are to be separated and purified.

Petroleum Refineries in India
Digboi (Assam), Barauni (Bihar), Haldia (West – Bengal), Matura (U.P.), Koyali (Gujarat), Trombay, Cochin, Chennai (Madras), and Visakhapatnam.

The process of separating and purifying the various hydrocarbons, the constituents of petroleum by fractional distillation taking into account their different boiling points is called refining of petroleum.
The products of petroleum are petroleum gas, petrol, kerosene oil, diesel oil, lubricating oil, paraffin wax and bitumen (Asphalt). Out of these products, lubricating oil, paraffin wax and bitumen or asphalt are not combustible.

PETROLEUM GAS

Petroleum gas is a mixture of three hydrocarbons i.e., butane (C_4H_{10}), propane (C_3H_8) and ethane (C_2H_6).
However, the main component is butane., all these constituents of petroleum gas are in gaseous state at room temperature. They burn easily and hence act as a source of heat energy. Out of these gases, butane can be easily liquefied under pressure.
Petroleum gas which is liquefied under pressure is known as liquefied petroleum gas (L.P.G.)
Liquefied petroleum gas (L.P.G.)
Liquefied petroleum gas (LPG) consists mainly of butane with small amount of propane and ethane under pressure.

The main constituent of LPG is butane.

This gas a filled in metal cylinders and used as a domestic fuel.
Liquefied petroleum gas (LPG) is highly inflammable. Any leakage of this gas can be dangerous. So to detect the leakage of LPG, some traces of sulphur compound (ethyl mercaptons = C_2H_5SH) giving a peculiar detectable smell is added in it.

Natural gas
Natural gas in another source of heat energy. It is a fossil fuel.

Main constituent of CNG is methane.

Composition. It mainly consists of methane (about 97%) and small quantities of ethane and propane.

Compressed natural gas (CNG)
When natural gas in liquid form is subjected to high pressure, we get compressed natural gas (CNG).

USE OF NATURAL GAS AND CNG

1. Natural gas and compressed natural gas are used as fuel of scooters, buses and trucks.
2. Natural gas is used for cooking food and heating water
3. Natural gas is used to produce elasticity.
4. Natural gas is used for manufacturing fertilizers.

DISADVANTAGES OF FOSSIL FUELS

Burning of fossil fuels has the following disadvantages.
(i) Burning of fossil fuels give rise to smoke, which pollutes our environment. The air pollution is harmful to human health, animals and plants.
(ii) Burning of fossil fuels give rise to harmful gases like carbon-dioxide carbon-monoxide, sulphur dioxide, nitrogen dioxide.

(iii) Gases produced due to the burning of fossil fuels give rise to acid rain after reacting with water vapours in air. For example, when carbon – dioxide, sulphur dioxide and nitrogen dioxide combine with water vapours in the atmosphere, acids are formed as follows :
Carbon dioxide + Water Carbonic acid
Sulphur dioxide + Water Sulphuric acid
Nitrogen dioxide + Water Nitric acid
These acids come down to the earth with rain. The rain containing acids is known as acid rain.
Acid rain decreases the fertility of the soil, destroys forests, makes adverse affect on the buildings and human beings and pollute water resources.
(iv) Burning of fossil fuels do not produce much heat.
(v) Burning of fossil fuels leads to global warming.

WHY ARE WE LOOKING AT ALTERNATE SOURCES OF ENERGY ?

In spite of number of disadvantages of fossil fuels, we mainly depend upon these fuels for our energy requirements. The growing demand for the energy to run industries and vehicles has accelerated the rate of extraction of the fossil duels. However, the deposits of fossil fuels are limited inequality and the formation of these fuels takes a very long period of time. Therefore, these source of fuels can be completely finished or exhausted in future. Hence, every effort is being made to use and extract the fossil fuels effectively to conserve these sources of energy.
Besides this, we look at alternate sources of energy like the sun, the wind, the ocean etc. to reduce the pressure on the use of fossil fuels.
New techniques have been discovered to produce electricity by burning fossil fuels. Thermal power plant produces electricity by burning the fossil fuels like coal and oil.

THERMAL POWER PLANT

A thermal power plant produces electricity by burning by fossil fuels (i.e., coal or oil). A schematic diagram of a thermal power plant is shown in figure 1.

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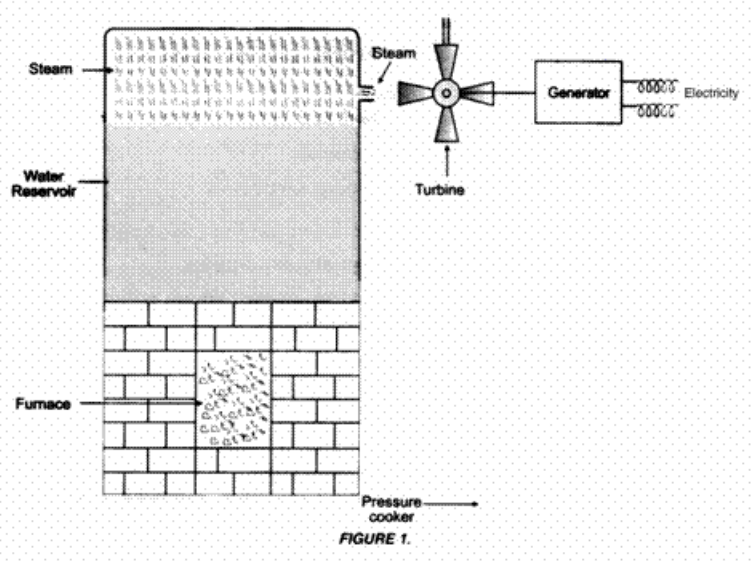


FIGURE 1.

WORKING OF A THERMAL POWER PLANT

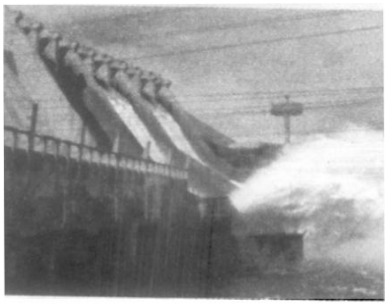
THERMAL POWER PLANT

Coal or oil is burnt in a furnace to produce heat energy. This heat energy is used to boil water in a reservoir. The steam produced in the water reservoir is allowed to fall on a turbine under high pressure. The steam falling on the turbine rotates it with high speed. A generator or dynamo connected with the turbine through an axle rotate with high speed and produce electricity. In fact, the mechanical energy (kinetic energy rotation) of the turbine is converted into electrical energy The electricity so produced is transmitted to distant places through transmission wires.

Thermal power plants are usually set up near coal fields or oil fields. This is because the fuel like coal or oil used in a thermal power plants is easily available and there is no problem in transporting the fael.

Disadvantage : The burning of coal or oil in a thermal power plant causes environmental pollution and global warming.

HYDRO POWER OR HYDRO ELECTRIC POWER PLANT



HYDRO POWER PLANT

Flowing water is the major source of energy. The electricity produced by the flowing water is known as hydro-electric power. A plant used to produce hydro-electric power is known as hydro-electric power plant (Figure).

A dam or water reservoir is made over a river. The energy of stored water in the dam is potential energy. The water in a dam is allowed to fall on the water wheel or turbine. As a result of this, the turbine rotates whose axle is connected with the armature of the generator. The armature of the generator rotates within two poles of a strong magnet. The rotation of the armature of' the generator between two poles of a strong magnet gives rise to electric current or electricity. This electricity is transmitted to the sub-stations through a transformer for further distribution to the houses and factories.

PRINCIPLE OF GENERATION OFT HYDROELECTRICITY

Potential energy of water stored in a dam is converted into kinetic energy of the falling water. The water falls on the turbine, so kinetic

25% of energy requirement in India is fulfilled by hydro electric power plants.

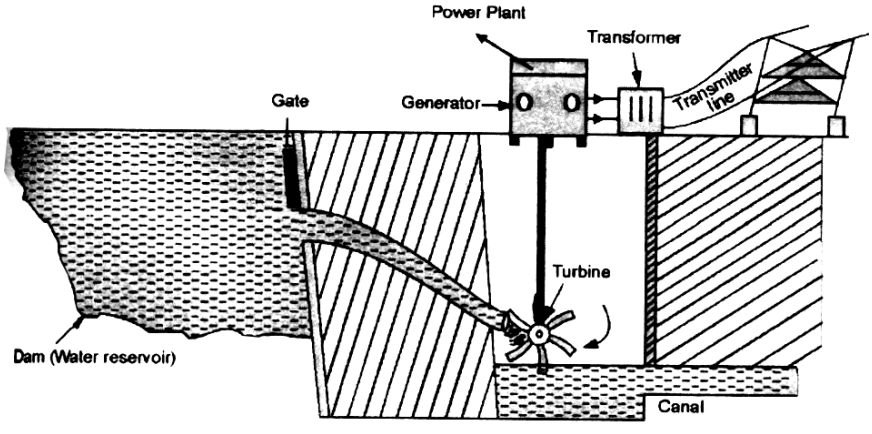


FIGURE 2

energy of the flowing water is converted into the kinetic energy of the of the armature of the generator connected to the turbine. Then kinetic energy is converted into the electrical energy known as hydroelectricity.

ADVANTAGES OF HYDROELECTRIC POWER

(i) Hydro electric power is pollution free.

(ii) Hydro electric power is dependable source of energy.

(iii) Lot of water is available in rivers, so the hydro electric power is available free of cost. Money is spent only to construct dams and power stations.

DISADVANTAGES OF HYDRO ELECTRIC POWER

(i) Hydroelectric power is generated only near the rivers having water throughout the year. This electric power has to be carried to the sub—stations for distribution to the houses and factories situated far off from the sites of hydro electric power stations. This is done through the transmission wires, so lot of money is to spent on this process.

Important Hydro electric power projects in India.
(i) Bhakra-Nangal project
(ii) Chamera Hydro electric project
(iii) Hirakud project
(iv) Koal kara project
(v) Nathpa jhaki Hydro project
(v) Ranjit Sagar Dam.

(ii) A large area of fertile land is submerged at the site of the dam constructed for tapping energy from the flowing water.
(iii) A large number of people residing near the site of a dam are dislocated. So, a lot of problems are to be faced in rehabilitating this population. That is why, there is a lot of opposition by the people around the site of dam for the construction of dam.
(iv) A large number of plants and wild life in the area of the dam is submerged in water. So, a large variety of flora (plants) and fauna (animals) is destroyed.
(v) Hydro electric dams cannot be constructed everywhere. Thery are constructed mostly in hilly areas.

Advantages of constructing Dams over rivers
Dams are helpful to :
(i) control floods over rivers
(ii) generate hydro electricity.
(iii) irrigate agriculture land.
(iv) develop water sports for recreation
(v) develop fishing zones.

IMPROVEMENTS IN THE TECHNOLOGY FOR USING CONVENTIONAL SOURCES OF ENERGY

Biomass

Green plants manufacture their food using sunlight by a process called photosynthesis. In fact, photosynthesis process converts solar energy into chemical energy. This chemical energy is stored in different parts of a plant in the form of biomass. Wood is a biomass which contains carbon and other combustible materials (i.e., cellulose and lignin). Any material containing carbon can be burnt in air to produce carbon-dioxide (CO_2) and energy in the form of heat energy i.e., it can be used as a fuel. Therefore, wood is used as the most conventional source of energy for household purposes and in industries.

Biomass is renewable source of energy if more and more plants are grown periodically.

Use of wood as a fuel
Wood can be used for generating heat energy in two ways i.e., directly and indirectly.

Direct Method
Firewood is burnt in traditional chulhas to generate heat for cooking food, heating water and warming rooms. Due to direct burning of wood, lot of smoke is produced which poses various problems like polluting the environment and hence causes serious health hazards. Moreover, complete combustion of wood does not take place, when wood is burnt directly and only small amount of heat is generated by burning huge quantity of wood. Thus, we conclude that direct method of burning wood is not suitable for generating good amount of heat energy.

Indirect Method
When wood is heated indirectly in the absence of air, it is converted into charcoal. The process is known as destructive distillation of wood. However, charcoal is very expensive than the wood because 1 kg of wood produces only 250 g ($0{\cdot}25$ kg) charcoal.

The process of heating dry wood in the absent of air is known as destructive distillation of wood. Burning of charcoal does not cause environmental pollution.

Charcoal is a better source of heat energy than the wood itself.
This is because
(i) when charcoal bums, it does not produce smoke. On the other hand, when wood burns, a lot of smoke is produced. Thus, burning of charcoal does not pollute the air, we inhale but burning of wood pollutes the air.
(ii) the heat energy produced by a given mass of charcoal is much higher than the heat energy produced by the equal mass of wood.
(iii) charcoal occupies leas space, so it poses no problem of storage.

(iv) charcoal is easily transported from one place to another.
(v) charcoal burns easily as compared to the wood.

Disadvantages of using charcoal as a domestic fuel

Although charcoal is clean and better source of heat energy but it is expensive fuel. Moreover, a lot of wood is needed to produce even a small amount of charcoal. So, huge amount of wood is required to produce charcoal for commercial purpose. It means, more and more trees are to be cut down for this purpose. It leads to deforestation which causes serious problems like soil erosion, floods, imbalance of eco-system etc. To avoid all these problems, it is not suggestive to use charcoal as a domestic fuel.

BIOGAS

Biogas is a mixture of various gases formed when the animal dung mixed with water is allowed to ferment (i.e. decompose) in the absent of air (or oxygen). Biogas is also called "gobar gas" as it is mostly obtained from the animals wastes.

The animals and plants wastes contain large quantity of carbon compounds like carbohydrates, fats, proteins etc. The bacteria or anaerobic micro-organisms present in animal dung decompose these compounds into simple compounds like methane (CH_4) in the presence of water.

Constituents of biogas

Biogas is a mixture of various gases such as methane (CH_4), carbon–dioxide (CO_2), hydrogen (H_2) and hydrogen sulphide (H_2S). The chief constituent of biogas is methane gas which is about 75% by volume. Methane is a very good fuel and acts as a source of heat energy because its heating capacity is high.

Raw materials used for the preparation of Biogas

The following materials are used for preparing biogas :
(i) Animal wastes like cow-dung, dung of buffaloes, horses etc. and poultry waste.
(ii) Human excreta.
(iii) Industrial and domestic wastes like fruits and vegetable wastes, willow dust, pulp etc.

BIOGAS PLANTS

The arrangement of producing biogas from animals dung, human excreta, industrial and domestic wastes is known as biogas plant There are two types of biogas plants which have been used in our country. These are :

Fixed-dome type biogas plant

(i) Fixed–dome type biogas plant
(ii) Floating gas holder type biogas plant.

Fixed-dome type biogas plant

Construction. Fixed-dome type biogas plant in shown in figure 3. It consists of a well like underground tank made of bricks and cement. This tank is called digester and has inlet and outlet valves. The roof of the tank is dome shaped. A gas outlet pipe at the top of the dome is fitted. The dome of the digester acts as a storage tank of biogas. There is a mixing tank made above the ground level which is connected to the inlet value of the digester through a slopping inlet chamber below the ground level. On the other side of the digester, a rectangular tank called outlet chamber is constructed with bricks and cement .

This outlet chamber is connected to the overflow tank which collects the used slurry.

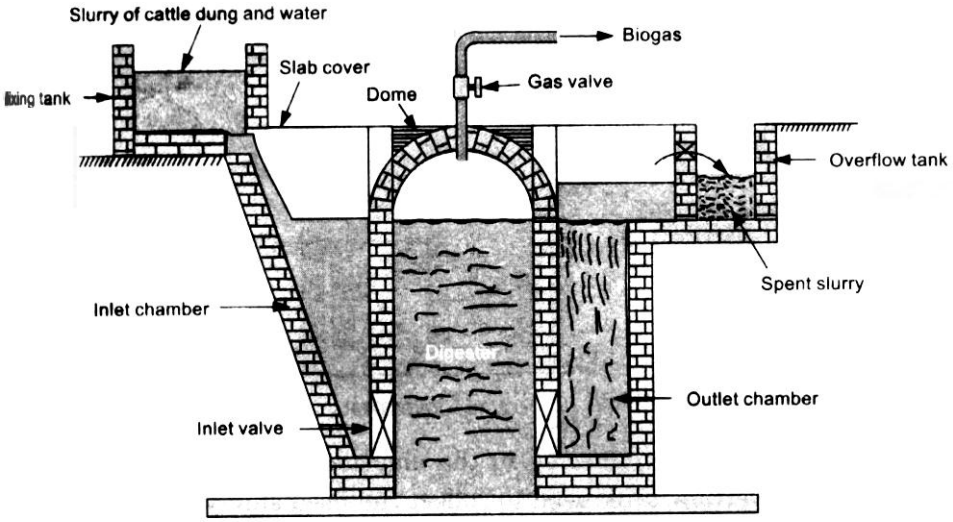


FIGURE 3

Working. Animals-dung is mixed with water to make slurry in the mixing tank. This slurry enters the digester through the inlet chamber. The digester is filled partially with slurry so that enough space is left above it in the dome for the collection of biogas. The slurry in the digester is left for about two months for fermentation. Anaerobic micro organisms are responsible for this action. As a result of fermentation, biogas is formed which is collected in the dome. When sufficient amount of biogas is collected in the dome, it exerts a large pressure on the slurry and forced it to go into the overflow tank through the outlet chamber. The biogas is taken out from the dome through a pipe and used for cooking food or heating water whenever required.

Once the biogas plant starts functioning, more and more slurry may be fed into the digester to get the continuous supply of biogas. The used slurry collected in the overflow tank is rich in nitrogen and phosphorous which are essential for the growth of crops and plants. Hence this used slurry can be used as manure.

Floating Gas holder type Biogas plant

construction. Floating gas holder type biogas plant is shown in figure 4. It consists of a well shaped tank inside the ground called digester. Digester is divided into two chambers with a partition wall (T). A drum shaped gas holder made of steel in the inverted position over the mouth of the digester acts as a storage tank for biogas. This tank moves up and down over the slurry in the digester tank and hence this gas plant is called floating gas holder type. The motion of the drum is controlled by a pipe.

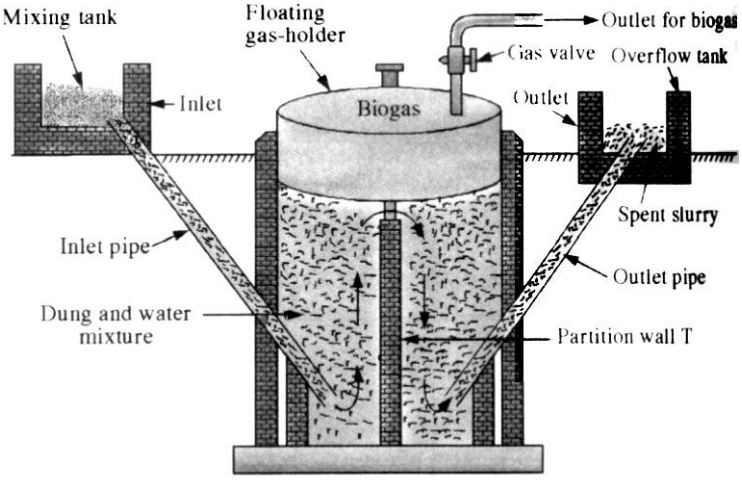


FIGURE 4. **DIGESTER**

Mixing tank is connected to the digester with the help of the inlet pipe. The overflow tank used to collect the used slurry is also connected by a pipe as shown in figure 4. The biogas collected in the floating tank is taken out with a pipe having a valve.

Working. Animals-dung and water in equal proportion are mixed in the mixing tank. The slurry so prepared is fed to the digester through the inlet pipe. It is left for a month and so in the digester. The fermentation of the slurry takes place in the digester and biogas produced is collected in the floating steel tank.

When enough amount of biogas is collected in the tank, it moves up. The pressure of gas over the slurry begins to increase when the steel tank stops rising beyond a certain limit. The large pressure of biogas pushes the slurry into the overflow tank through the outlet pipe. The gas collected in the tank is taken out through a pipe for cooking food and heating water.
The slurry collected in the overflow tank is used as manure as it contains nutrients like nitrogen and phosphorous which are essential for the growth of crops and plants.
More slurry is added into the digester tank to get the continuous supply of biogas for daily use.

Advantages of using biogas
Biogas is used for cooking food and heating water. It is a good source of energy because
(i) biogas does not produce smoke during burning and hence there in no air pollution.
(ii) it is a cheaper source of energy,

HYDROGEN FUEL

Hydrogen has been recognised as a potential source of heat energy. When hydrogen is produced from renewable sources such as hydro (i.e., water), solar and wind energy, it becomes a renewable source of heat energy (i.e., fuel).

Uses of hydrogen as a fuel
(i) A mixture of hydrogen and carbon monoxide is burnt as a fuel for cooking food and heating water.
(ii) Hydrogen is used as a fuel to nm vehicles.
(iii) Liquid hydrogen is used as a fuel in space ships or space crafts as it occupies less space.

Advantages of using Hydrogen as a fuel
(i) Burning of hydrogen produces very large amount of heat energy.
(ii) Burning of hydrogen creates less air pollution.

Disadvantages of Hydrogen as a source of energy
(i) When hydrogen bums with oxygen, the reaction is explosive in nature. So using hydrogen as a source of energy is full of risk. As a result, hydrogen is not used as a domestic fuel.
(ii) Hydrogen cannot be stored and managed easily by a common man.
(iii) Hydrogen cannot be transported easily.
(iv) Hydrogen is an expensive fuel.

WIND ENERGY

FIGURE 5

Air in motion is called wind. As a moving object possesses kinetic energy, so wind has also kinetic energy. The kinetic energy of the wind is also known as wind energy.

Uses of wind Energy
The kinetic energy of the wind can be used to
(i) move the sail boats in lakes, rivers and seas.
(ii) operate water pumps to draw underground water.
(iii) run the flour mills to grind the grains (i.e., maize, wheat, corns etc).
(iv) produce electricity.

WIND MILL
A device used to convert wind energy into the mechanical energy of the machine is called wind mill.

Construction
It consists of a wheel with blades cut into its outer rim. The wheel rotates about an axle mounted on a pole (Figure 5). The wind energy is used to rotate the wheel about its axle.

Sequence of energy conversion in a wind mill.
Wind energy $\rightarrow$ Mechanical energy $\rightarrow$ Electrical energy.

Uses
Wind mill is used for operating water pumps, girders rotates also used to produce electricity.

Wind mill for producing electricity (Wind Generator)
Electricity is produced when an armature of a generator rotates between two poles (North and South poles) of a strong magnet. When wind falls on the

wheel of a windmill, it rotates. The axle of the armature is connected to the shaft of the wind mill. So the armature of the generator rotates between two poles of a magnet along with the rotation of the wheel of the wind mill (Figure 6). Thus, electric current is produced. This is how, the kinetic energy of the wind is converted into electric energy.

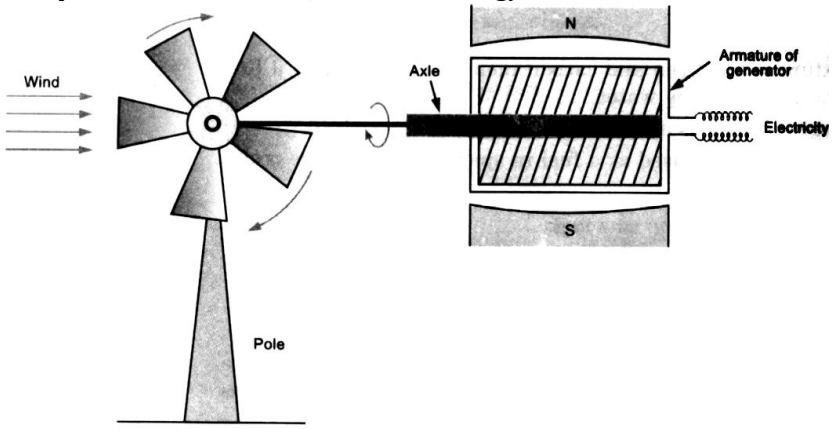


FIGURE 6

It may be noted that electricity produced by a single wind mill is very small, which cannot be used for commercial purpose. To produce electricity on a large scale, a large number of wind mills are erected in high wind energy region. The region where large number of wind mils are erected to produce electricity is called wind energy farm. The small amount of electricity produced by each generator connected to each wind mill is combined to get electricity on a large scale.

ADVANTAGE OF WIND ENERGY

(i) Wind energy produces no smoke and no harmful gases. So this form of energy is pollution free.
(ii) Wind energy is free of cost and hence devices operated by wind energy are economical.
(iiii) This source of energy is inexhaustible i,e., it is limitless and is available for all times to come under favourable conditions.

LIMITATIONS OF WIND ENERGY

(i) We cannot depend upon wind energy as it is available only when air is in motion. The appliances or machines operating with wind energy stop working as soon as wind stops. The minimum speed of wind to operate generator to produce electricity is about 15 km/h. As soon as the speed of the wind become less than 15 km/h, the generator stops working.
(ii) There are certain regions where wind is not available, so the use of wind energy is limited to certain places where wind is in plenty and blows most of the time.
(iii) Wind energy is not sufficient to operate very heavy machines.
(iv) Wind energy cannot be used to operate all types of machines.

WIND ENERGY FARM

WIND ENERGY IN INDIA

In India, there are some high wind energy regions. They are
(i) Islands of Bay of Bengal and Arabian Sea (ii) Coastal parts of Gujarat and Tamil Nadu and (iii) Some parts of Rajasthan, Karnataka and Western parts of Madhya Pradesh. Govt. of India has proposed to install number of projects to tap the wind energy.
In Gujrat, two wind power energy stations are operating. One is at Lamba in Porbandar district. The second power station operating with wind energy is in Okha.
It has been estimated that wind power (electricity from wind) potential of our country is about 20,000 MW. India's largest wind farm near Kanyakumari in Tamil Nadu is generating 380 MW electricity. Our country is producing about 1030 MW electricity from the wind.

ALTERNATIVE NON-CONVENTIONAL SOURCES OF ENERGY

With the development of technology and the invention of new devices and machines, the demand for the consumption of energy is increasing day by day. Our life has become more comfortable than our ancestors. This is because we have a good network of transport like scooters three wheelers, buses, cars, trucks, aeroplanes, ships etc.,

many devices like radios, televisions, VCRs, tape recorders, music systems for our entertainment ; various machines like tractors for ploughing fields ; pumps and motors to draw underground water ; computers, fax machines telephones and mobiles etc. All these devices or machines need energy in one form or the other for their operations. For our energy requirement, we mainly depend upon the conventional sources of energy (or non-renewable sources) like coal, petroleum, natural gas etc. These sources are limited in quantity and can be finished completely (i.e., exhausted) in near future. This is because of their ontinuous and rapid use. Thus, a stage is bound to come when these sources of energy will be out of stock. This would create an energy crisis on the earth. To overcome this energy crisis, the scientists have accelerated the search and use of renewable sources of energy—like the solar energy.

SOLARENERGY

The energy emitted by the sun in the form of heat and light (i.e., radiation) is known as solar energy.
The Sun contains mainly light elements like hydrogen and helium When the nuclei of these elements fuse together at extremely high temperature in the interior of the Sun, a large amount of energy is radiated in the form of heat and height continuously by the Sun. This process is known as Nuclear fusion. (Note. Nuclear fusion is discussed in the article 5.10.6). All the planets of the solar system receive the energy emitted by the Sun. The energy is emitted by the Sun in the form of radiation. These radiations are visible rays, infra-red rays (i.e., heat radiation), ultraviolet radiation, gamma rays, X–ray and radio waves. It may be noted that only some fraction of the total energy emitted by the Sun reach the surface of the earth.
Measurements have shown that the upper part of the earth's atmosphere receives solar energy equal to 1·4 kilo joule per second per square metre ($1{\cdot}4\,kJ / s\,m^2$). This amount is known as Solar constant.

Thus, Solar constant $= 1{\cdot}4\,kJ / s\,m^2$

Since $J / s = Watt\,(W)$

$\therefore$ Solar constant $= 1{\cdot}4\,kW / m^2\ or\ 1{\cdot}4\,kWm^{-1}$

Definition of Solar constant

Solar constant is defined as the energy received from the sun in one second by the unit square metre area of the outer edge of earth's atmosphere exposed perpendicular to the radiation of the Sun at an average distance between the earth and the Sun.
The amount of solar energy received at the surface of the earth is always less than the solar constant. This is because large amount of solar energy is absorbed by the atmosphere of the earth.
The remaining energy is reflected back to the space. Most of the ultraviolet rays (which are harmful to living things) are absorbed by the upper part of the atmosphere known as ozone layer. Mostly visible rays and infra-red rays reach the surface of the earth. The solar energy received by the earth is absorbed by land, rivers, oceans and lakes. This absorbed energy causes many natural phenomena like wind, storm, rain, snowfall, and sea waves. This energy is also used by plants to manufacture their food by a process known as photosynthesis.

Traditional Uses of Solar Energy : It is used
(i) for cooking food using solar cookers.
(ii) for heating water using solar water heaters.
(iii) for producing steam by heating water to produce electricity.
(iv) by green plants to make their food.
(v) to produce electricity using solar cells.
(vi) to melt metals using solar furnaces.
(vii) for drying clothes and food grains.

Ultraviolet rays are absorbed by ozone layer.

SOLAR ENERGY DEVICES

A large number of devices have been developed to harness the solar energy directly. The commonly used devices are : solar cookers solar furnaces, solar water heaters, solar power plants and solar cells etc.

Methods of Collecting Solar Energy

Solar energy can be used for heating purpose by collecting and focusing it on the object to be heated. It can be done as described below :
(i) Sun rays are reflected by plane mirrors on the black containers. Solar radiation are reflected by plane mirrors to fall on the black containers containing un-cooked food. The black containers are used because black body absorbs more heat radiation than the white or polished one.
Solar cookers and heaters are based on this principle. This method is used where moderate temperature is required.

(ii) The sun rays are focussed at a point using concave reflectors. The solar radiation falling on the concave reflectors are focussed at a point. Thus, large amount of heat radiation concentrated at a point increases the temperature of that point to a high value.
Solar furnaces and solar power plants are based on this principle. This method is used where relatively high temperature us required.

Interior of Solar Cooker are painted black

Black surfaces are good absorbers of heat as compared to white surfaces or smooth surfaces. That is why/ the interior of solar cookers or other solar energy devices are painted black.

SOLAR COOKERS

1. SOLAR COOKER (BOX TYPE)

Construction

It consists of a wooden box (rectangular in shape) in which a metallic box painted black is fitted. The space between wooden box and metallic box is filled with an insulating material like thermocol. The insulting material minimizes the heat lose by conduction and radiation.
The metallic box is covered by a thick glass sheet. A plane mirror reflector is used to reflect the sun rays and attached to the box (Figure 7). The un-cooked food placed in the black container is put inside the box.

SOLAR COOKER

WORKING

The plane mirror reflector is adjusted in such a way that maximum sun light falls on it. The light reflected by the plane mirror falls on the thick glass sheet cover.

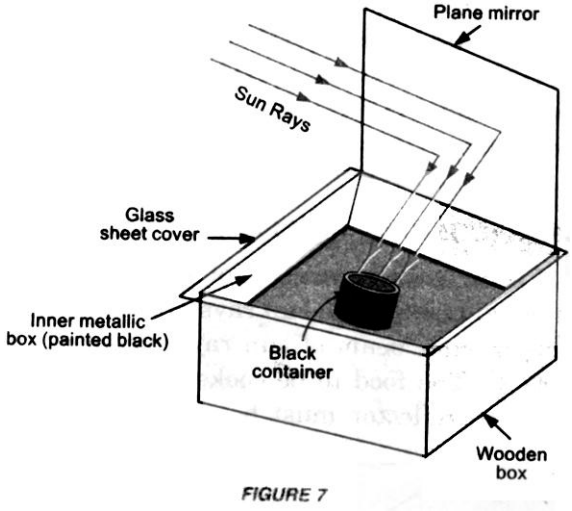


FIGURE 7

The heat radiation (i.e. infra-red rays coming from the sun and have short wavelength and high energy) pass through the glass sheet and are absorbed by the black container or any other object placed in the box and black surface of the box. The heat radiation entered in the box are not able to come out of the box through the glass sheet. Thus, the heat radiation are trapped in the box. (The effect is known as green house effect. For the detail of green house effect, Refer Additional Topic at the end of this chapter). The temperature inside the box increases from $100^{o}C$ to $140^{o}C$. Thus, the food in the container is cooked.

ADVANTAGES OF BOX TYPE SOLAR COOKER

1. Economical : The cost of cooking food in the solar cooker is very small as money is only spent to purchase the solar cooker.
2. Pollution : No pollution is caused as there is no burning of fuel.
3. Nutrition value of food is preserved as the food is cooked at low temperature.
4. It can cook two or three dishes at a time.
5. It saves the costly fuel like wood, gas, kerosene oil etc.

DISADVANTAGES OF SOLAR COOKER

(i) Food cannot be cooked at night.

(ii) Food cannot be cooked on a cloudy day.
(iii) Food cannot be cooked quickly as solar cooker takes 4 to 5 hours to cook it.
(iv) Large quantity of food cannot 6e cooked with the solar cooker.
(v) Chapati's cannot be made with this cooker.
(vi) Food cannot be fried.
(vii) The position of the reflecting plane mirror has to be changed time and again so that it always face the sun.

SOLAR CONCENTRATORS

Solar concentrators are the devices used to concentrate the solar energy over a small area. When a parallel beam of sunlight falls on a polished concave surface (like concave mirror), then the beam of sunlight concentrates at the focus (F) of the concave surface after reflection (Figure 8). As a result of this concentrated beam of sunlight, the temperature at point F increases considerably. If we place a piece of paper at F, then it begins to burn after some time. A concave spherical surface which concern. trates the beam of sunlight at a point is called solar concentrator.

SOLAR COOKER (CONCAVE REFLECTOR TYPE)

This type of solar cooker consists of a large concave reflector or solar concentrator (Figure 8). The sun rays are focussed by this reflector at a point F. The intense beam of sun rays increases the temperature of point F to 200° C. The food to be cooked in a container is placed at point F. The concave reflector must be rotated so that it always face the Sun for effective cooking of the food.

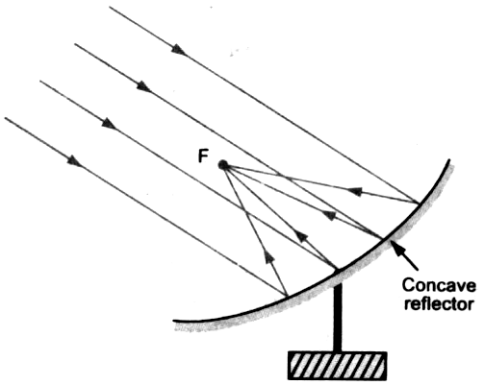


FIGURE 8

Differences between Box Type solar cooker with plane Mirror and Box Type solar cooker with spherical Reflector

Solar cooker with plane Mirror solar (Box type cooker)	**Solar cooker with spherical Reflector**
1. Plane mirror is used to reflect the sun light.	1. Concave mirror or surface is used to reflect the sun light.
2. The temperature inside the box of the solar cooker rises to 100^oC to 140^oC.	2. The temperature inside the box of the solar cooker rises to 200^oC.
3. It cannot be used for frying the food and making chapattis.	3. It can be used for frying the food and making chapattis.

SOLAR FURNANCE

It consists of a large number of movable plane mirrors and a parabolic reflecting surface. Plane mirrors reflect the sun light towards the parabolic reflecting surface. The parallel beam of light falling on the parabolic mirror is focussed at a small area (F) as shown in Figure.

The temperature of the small area where beam of sun light is focussed may be raised to 3000^oC.

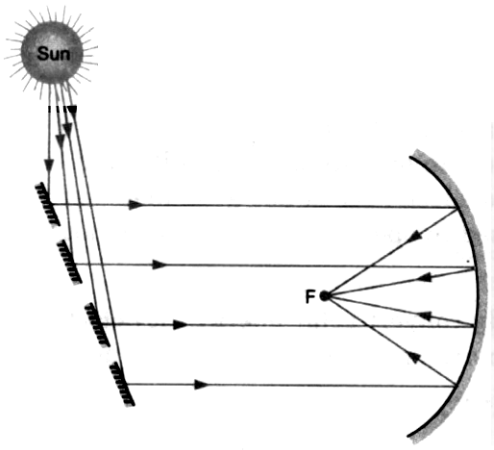


FIGURE 9

Use : A water reservoir placed at F is heated to produce steam. This steam under high pressure is used to rotate the turbine of a generator to produce electricity. A solar furnace when used to produce electricity is known as solar power tower.

Advantages of Solar Devices

(i) These devices save the costly fuel like wood, gas, kerosene, diesel etc.
(ii) These devices cause no pollution and hence they are environment- friendly.
(iii) The repair and maintenance is very cheap.

Limitations of Solar devices

(i) They cannot work during night.
(ii) They cannot work on cloudy and rainy days.
(iii) They are less effective during winter season.
(iv) They are not effective in polar regions.
(v) They cannot be used to operate automobiles like buses, cars, ships, and aeroplanes.
(vi) They cannot be used to operate heavy machinery.
(vii) Their initial cost is high.

SOLAR CELL

A device which converts sunlight into electrical energy is known as solar cell.

Semiconductors and Solar cells

A substance whose conductivity lies between those of a conductor and an insulator is known as semiconductor.
Examples : Silicon and Germanium are semiconductors.

How to make a Solar cell ?

The layers (i.e. wafers) of semiconductor material like silicon having impurities are placed one over the other. When sunlight falls on these wafers, a potential difference is produced between the two regions of semiconductor's wafers. This potential difference give rise to an electric current. Thus, a device which converts sunlight into electrical energy is ready. A solar cell made of semiconductor (Germanium or Silicon having Gallium as impurity) has an efficiency about 10—15%.

Uses of Solar Cells

(i) They are used in wrist watches and calculators.
(ii) They are used to generate electricity needed in artificial satellites (i.e., man made satellites).
(iii) They are used to operate electric bulbs and tubes in remote an where hydro-electricity is not available.
(iv) They are used to operate radio sets in remote areas.

Advantages of Solar Cells

(i) They directly convert solar energy into electrical energy.
(ii) They are environment-friendly i.e. they do not cause pollution.

SOLAR PANEL

A group of solar cells connected to each other in a certain pattern forms a solar panel (Figure 10).
from a solar panel (Figure 10).

SOLAR PANEL

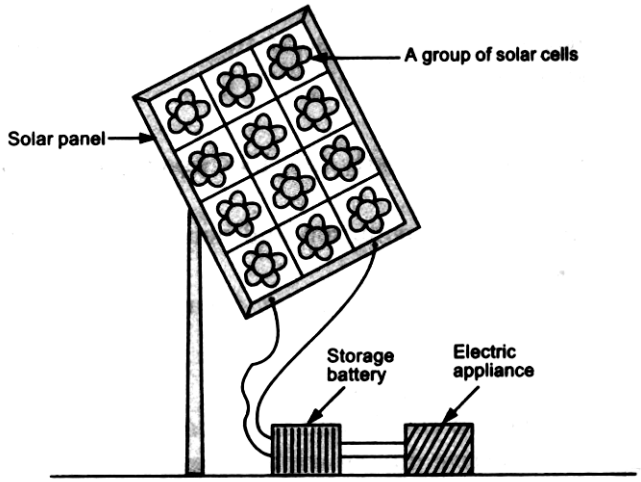


FIGURE 10

A solar panel converts sunlight into electrical energy. The efficiency of solar panel is very large as compared to the efficiency of a solar cell.
During day time, sunlight falling on the solar panel is converted into electrical energy which is stored in a battery connected to it. As soon as sunlight stops falling on it (during night and cloudy day), the battery begins to supply electric current to the appliances connected to it.

Limitations
Solar panels have limited uses. They can not be used to meet our domestic needs of electricity. This is because of the following reasons :
1. The solar cells used in a solar panel are made of pure silicon. The production of pure silicon is very costly affair. These solar cell in a solar panel are joined to each other with a best conductor silver to reduce the resistance of the solar panel to get maximum electricity. But silver metal is also costly. Thus, we find that the cost of fabricating a solar panel is very high.
2. The storage battery connected to a solar panel can supply direct current (D.C.). So only those electric appliances can operate with the solar panel which require direct current. However, the electric appliances which require alternating current (A.C.) cannot be operated with the solar panel.
3. Solar ponel can supply the electricity continuously only if the sun shines during day time.

Uses of solar Panels
(i) They are used to operate electric bulbs and tubes in the remote villages and areas.
(ii) They are used to supply electricity in artificial satellites.

ENERGY FROM THE SEA OR OCEAN

The sun heats the water in the oceans, rivers, ponds etc, As the specific heat capacity of water $(4200\,Jkg^{-1}\,{}^{o}C^{-1})$ is very high, so the water in oceans is a store house of heat energy. The energy from sea or ocean water is available in the following forms :
(i) Energy of sea waves
(ii) Tidal energy
(iii) Ocean thermal energy

(I) Energy of sea waves
High winds blow across the sea. These winds produce high waves on the surface of water in the sea or ocean. Thus, the water in the sea moves. The kinetic energy of this moving water rotates the turbine of a generator. Hence electricity is produced.
Limitation of energy of Sea waves. Energy of sea waves car extracted only if strong winds blow all the times across the sea. However, as soon as strong winds stop to blow, the generator stops producing electricity. Hence, we cannot depend much on the energy of sea waves.

(II) Tidal Energy

The alternate rise and fall of waters of the ocean twice in nearly 24 hours is known as tides. The tides are caused due to the gravitation force of attraction exerted by the moon and to some extent by the on the water of the ocean. At the time of new and full moon, when the sun and the moon are in a straight line, tides are very high. When the sun and the moon are at right angle from the earth, tides are low. The kinetic energy of water during tides is used to produce electricity.

Tidal power plants are constructed near narrow Bays (Figure 11). During tides, the gates of the dam are opened. The rising water is allowed to fall on the turbine of the generator which produces electricity. Thus, kinetic energy of the water is converted into electrical energy.

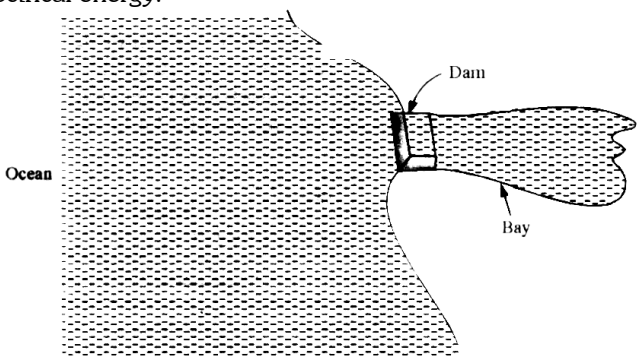


FIGURE 11

During low tides, gates of the dam are closed and hence the water level behind the dam rises. This raised water has potential energy. Again the gates are opened and the water is allowed to fall back into the bay. This falling water is used to rotate the turbine of the generator. Hence the electricity is produced continuously.

Places where Tidal energy is taped

France and Canada are the leading counries which harness the tidal energy.

In India, three sites namely Gulf of kutch (Gujrat), Gulf of Cambay (Gujrat) and Sunderbans (West Bengal) have been identified to construct tidal power plants.

Limitation of Tidal Energy

To operate tidal power plant, the difference between the water levels of high tide and low tide should be very large. This much level of tide is not available at all coastal places. Thus, tidal power plants can not be installed everywhere. In other words, tidal energy cannot be major source of energy.

(iii) Ocean Thermal Energy (OTE)

The heat energy due to the temperature difference between the different layers of water in the ocean is known as ocean thermal energy (OTE). The temperature of water at the surface of the ocean is much more than the temperature of water deep into the ocean. Due to this temperature difference, heat energy can be drawn from the sea or ocean water. This heat energy can be used to produce electricity.

Ocean Thermal energy conversion (OTEC) power plant

A device used to obtain ocean thermal energy is known as Ocean Thermal Energy Conversion (OTEC) power plant. For operating OTEC power plant (Figure 12), temperature difference of 20°C or more between the surface water of ocean and water deep into the ocean is required. The warm surface water of ocean is used to boil liquid like ammonia or chlorofluoro carbon (CFC). The vapours of this liquid at high pressure are used to rotate the turbine of the generator to produce electricity. The unused vapours (known as dead steam) are again converted into liquid by the cold water pumped up from the deep ocean. This process is repeated time and again to convert ocean thermal energy into electric energy {i.e., electricity). The main advantage of OTEC power plant is that it can be operated for 24 hours throughout the year.

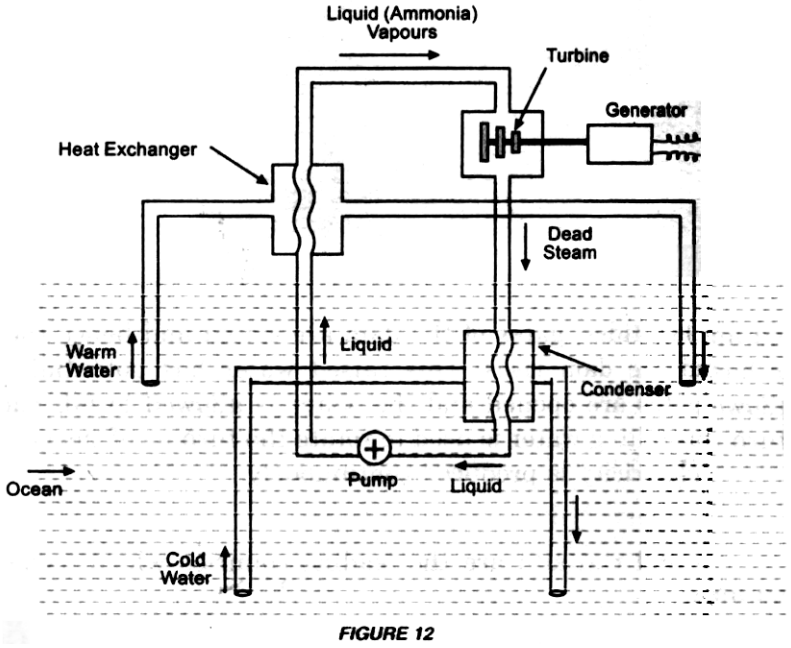


FIGURE 12

GEO-THERMAL ENERGY (GEO-THERMAL MEANS EARTH-HEAT)

The earth has three layers i.e., the core, the mantle and the a crust. The core is the central part of the earth which is surrounded by the mantle. The mantle is surrounded by the uppermost layer of the earth called the crust. The mantle of the earth has molten mass called magma. This magma consists of molten rocks, gases and steam very high temperature. Due to some geological changes, the hot magma rises up and is collected in the crust of the earth. The regions in the crust where the hot magma is collected are called hot spots. The heat energy stored in the hot spots of the earth's crust is called geo-thermal energy. This energy heats the underground water. The hot underground water comes automatically out of the earth's surface in certain regions where crust is weak in the form of fountains known as hot water springs or geysers.

Geo-thermal energy is not derived from the sun.

The steam of underground water is usually taken out by sinking pipes through holes drilled in the earth's crust. This steam under high pressure is used to rotate the turbine of the generator to produce electricity.

Advantages of Geo-thermal energy

1. Geo-thermal energy can be converted continuously into electricity for 24 hours throughout the year.
2. Geo-thermal energy causes no pollution, so it is environment friendly.
3. The cost of converting geo-thermal energy into electricity is very less.

Places where Geo-thermal energy based power plants are located

Geo-thermal energy based power plants operate in large number in USA and New Zealand. However, one such plant also operates in Madhya Pradesh (India).

NUCLEAR ENERGY

Antonie Henri Becquerel, a French physicist discovered that uranium emits radiation spontaneously. The spontaneous emission of radiation by uranium or heavy elements is known as radioactivity. Thus, Becqueral discovered radioactivity. A substance or element that shows the property of radioactivity is known as radioactive substance or radioactive element.

In 1897, Rutherford found that the radiation emitted by radioactive elements are of three types (i) alpha particle (alpha particle is a helium nucleus i.e., a helium atom which has lost its two orbital electrons), (ii) beta particle (beta particles are the streams of fast moving electrons) and (iii) gamma rays (radiation of small wavelengths).

When a radioactive substance emits radiation, its mass decreases. Suppose M be the mass of a radioactive substance before emitting the radiation and M' be the mass of the substance after emitting the radiation. Therefore, the decrease in the mass of the substance is given by

$$\Delta m = (M - M')$$

This decrease in mass (Am) is converted into energy E according to Einstein's s mass - energy relation, $E = \Delta mc^2$, where $c = 3\times10^8\ ms^{-1}$ is the speed of light in vacuum. The energy E is known as nuclear energy.

Definition : The energy obtained from the conversion of nuclear mass is known as nuclear energy.

Units of Nuclear Energy

Nuclear energy is expressed in electron-volt (eV). One electron- volt is the energy acquired by an electron while passing through a potential difference of one volt.

$$1eV = 1{\cdot}6\times10^{-19}\ C\times1V = 1{\cdot}6\times10^{-19}\ CV$$

or $1eV = 1{\cdot}6\times10^{-19}\ J \qquad (\because 1CV = 1J)$

Bigger unit of nuclear energy is mega electron-volt (MeV).

$$1MeV = 10^6\ eV = 10^6\times1{\cdot}6\times10^{-19}\ J = 1{\cdot}6\times10^{-13}\ J$$

Nuclear energy is obtained by the splitting of a heavy nucleus into light nuclei and by combining light nuclei to form a large nucleus. The process of splitting of a heavy nucleus is known as nuclear fission. The process of combining light nuclei to form a large nucleus is known as nuclear fusion.

NUCLEAR FISSION

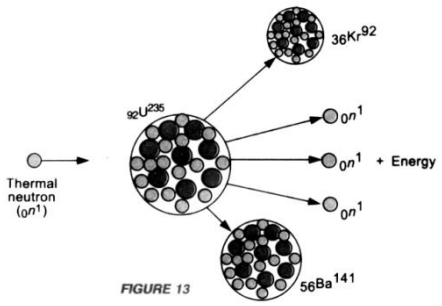


FIGURE 13

The process of splitting a nucleus is known as nuclear fission.

Otto Hahn and Strassman found that uranium-235 bombarded by a neutron splits up into two comparatively lighter nuclei. This process is known as nuclear fission. The neutrons used in the fission of uranium nucleus have low energy and are known as thermal neutrons. During the fission of uranium, two or three neutrons are also emitted along with the release of large amount of energy besides the products of the fission.

Definition of Nuclear fission

The process of splitting a heavy nucleus into two comparatively lighter nuclei along with the release of large amount of energy when bombarded with a thermal neutron is called nuclear fission.

Nuclear fission of ${}_{92}U^{235}$ when bombarded with a slow neutron (known as thermal neutron) is given below :

$${}_{92}U^{235} + {}_0\ n^1 \rightarrow {}_{56}\ Ba^{141} + {}_{326}\ Kr^{92} + 3\ {}_0n^1 + energy$$

This fission is represented as shown in figure 13.

The energy released per fission of ${}_{92}U^{235}$ (an isotope of uranium) is about 200 MeV.

Note : It may be noted that nuclear energy produced by the fission of 1 kg of uranium - 235 is equal to the energy produced by the burning of 25,00,000 kg coal.

ATOMIC POWER PLANTS AND RESEARCH CENTRES IN INDIA

(i) Bhabha Atomic Research Centre at Trombay near

Mumbai : This centre has been established to carry out research work to use nuclear energy for peaceful purposes.

(ii) Tarapur Atomic Power Station (in Maharashtra) was the first atomic power station established in India.

(iii) Rajasthan Atomic Power Station at Rana Pratap Sagar near Kota.

(iv) Narora Atomic Power Station at Narora in Uttar Pradesh.

(v) Madras Atomic Power Station (now known as lndira Gandhi Centre for Atomic Research) at Kalpakkam in Tamil Nadu.

India gets most of uranium from the Jaduguda mines in Bihar. The uranium obtained from these mines is taken to Nuclear Fuel complex situated at Hyderabad for processing. At this complex, the fuel elements are formed after enriching the uranium. These fuel elements are then sent to different Nuclear power plants.

HAZARDS OF USING NUCLEAR ENERGY (POLLUTION FROM NUCLEAR FISSION)

Nuclear fission causes more scrious pollution problem than fossil fuels. Nuclear fission radiates nuclear radiation namely alpha particles (a-particles), beta particles (p-particles) and gamma rays ($\gamma-$rays). These radiation are very harmful to the living organisms. The long and constant exposure of living organisms to these radiations cause many diseases or disorder in the human body like :

(i) The nuclear radiation can change or damage the structure of cells in the human body.

(ii) They cause diseases like cancer, leukemia and blindness.
(iii) They cause genetic disorder in a human body.
(iv) They cause sterility in young generation.

ADVANTAGES OF USING NUCLEAR FISSION ENERGY OVER FOSSIL FUELS

About 3% of the total energy produced in India is obtained from Nuclear Power plants.

(i) A small quantity of nuclear fuel (U-235) gives a large amount of energy by the process of nuclear fission. While large quantity of fossil fuel is required to produce large amount of heat. For example, 1 kg of Uranium 235 releases energy equivalent to the energy released by the burning of 25,00,000 kg coal.
(ii) In a nuclear power plant, the nuclear fuel is inserted once to get energy over a long period of time. On the other hand, in a thermal power plant, fossil fuel is to be supplied constantly to get the energy.

DISADVANTAGES OF NUCLEAR FISSION ENERGY OVER THE FOSSIL FUEL ENERGY

1. Nuclear fission causes more serious pollution problem than the burning of fossil fuel. The radiation emitted during nuclear fission are very harmful. They cause dangerous diseases like cancer, leukemia and sterility.
2. The biggest problem of using nuclear fission energy is the safe disposal of nuclear waste. Nuclear waste continues to emit harmful nuclear radiation. No method has been evolved for the complete elimination of the nuclear waste. But no such problem is faced in the disposal of the fossil fuel waste. For example, burning of coal give rise to ash which can be thrown in the fields.

NUCLEAR FUSION

Definition : The process in which two or more light nuclei fuse together (or combine) to form a heavy nucleus along with the release of energy is called nuclear fusion.

Example : (i) When two nuclei of deuterium (d or ${}_1H^2$) fuse together, the following products are formed :

$$d + d \rightarrow t(tritium) + p(proton) + 0{\cdot}4\,MeV$$

or $${}_1H^2 + {}_1H^2 \rightarrow {}_1H^3 + {}_1H^1 + 4{\cdot}0\,MeV$$

(ii) When tritium $({}_1H^3)$ fuse with deuterium $({}_1H^2)$, the following products are formed :

$${}_1H^3 + {}_1H^2 \rightarrow {}_2He^4 + {}_0n^1 + 17{\cdot}6\,MeV$$

(iii) When two protonium fuse together, deuterium (d), positron (e^+) and neutrino (v) are formed

i.e., $$p + p \rightarrow d + e^+ + v + 0{\cdot}42\,MeV$$

or $${}_1H^1 + {}_1H^1 \rightarrow {}_1H^2 + {}_1e^0 = v + 0{\cdot}42\,MeV$$

Positron (e^+) is identical to electron. The only difference between positron and electron is that positron has + 1 charge and electron has —1 charge. Neutrino is a neutral particle (i.e., no charge) and its rest mass is zero.

HOW A NUCLEAR FUSION TAKES PLACE ?

The fusion of nuclei does not take place so easily as it seems to be. In fact, nuclei are positively charged and hence they repel each other when come closer to each other. These nuclei can be fused together if they move with very high speed to overcome the force of repulsion between them. This can happen if the temperature is very high (about $10^7 K$). At this temperature, the electron of the hydrogen atom is completely detached and hence we get a bare nucleus (i.e. naked nucleus) and free electron. The collection of bare nuclei moving very high speed and free electrons is known as Plasma. Since the number of bare nuclei of positively charged) is equal to the number of electrons (negatively charged), hence net charge on Plasma is zero. These bare nuclei of
hydrogen move with very high speed (because speed is proportional to he temperature) and hence fuse together to form helium nuclei. During the fusion of hydrogen nuclei, a large amount of energy is released.

IMPORTANT INFORMATION

Since very light temperature is required o produce nuclear fusion, so nuclear fusion reaction is also known as thermonuclear reaction.

Source of Energy of the Sun-Nuclear Fusion

Hans Bethe in 1939 suggested that the source of energy of the Sun and other stars is thermo—nuclear or nuclear fusion reactions.

ADVANTAGES OF NUCLEAR FUSION OVER NUCLEAR FISSION PROCESS

1. The energy released in nuclear fusion is much more than the energy released in nuclear fission reaction.
2. In a nuclear fusion, hydrogen nuclei fuse together to form a helium nucleus which is stable. Helium nucleus does not emit any type of harmful radiation. So, we can dispose off it easily. On the other hand, by products of nuclear fission reaction emit harmful radiation. Hence, the disposal of these product is a big problem.

Disadvantage of Nuclear fusion

It is still in the experimental stage to have controlled nuclear fusion to produce electricity. The main problem is to contain the ingredients of nuclear fusion at a extremely high temperature.

DIFFERNCE BETWEEN NUCLEAR FISSION AND NUCLEAR FUSION

Nuclear fission	Nuclear fusion
1. In a nuclear fission, a heavy nucleus splits up into lighter nuclei.	1. In a nuclear fusion, light nuclei combine together to form a heavy nucleus.
2. In a nuclear fission, harmful nuclear radiation are emitted.	2. In a nuclear fusion, no harmful radiation are emitted.
3. A nuclear fission starts when a slow neutron bombards the heavy nucleus (like Uramum-235),	3. A nuclear fusion starts when light nuclei are heated at a extremely high temperature.
4. Nuclear fission is a chain reaction.	4. Nuclear fusion is not a chain reaction.
5. Nuclear fission reactions can be controlled to produce electricity.	5. Nuclear fusion reactions are still uncontrolled and cannot be used to produce electricity.
6. Nuclear fission reactions produce a large amount of energy.	6. Nuclear fusion reactions produce much more energy than the nuclear fission.
7. Temperature plays no role to start nuclear fission reaction.	7. Temperature of the order of $10^{7\ 0}K$ is required to start nuclear fusion reaction.
8. By-products of nuclear fission are radioactive and emit harmful radiation.	8. By-products of nuclear fusion are not radioactive and hence do not emit harmful radiation.
9. Nuclear fission causes more pollution.	9. Nuclear fusion causes no pollution.
10. In a nuclear fission, the disposal of nuclear waste is a big problem.	10. In a nuclear fusion, no such problem is there.

ENVIRONMENTAL CONSEQUENCES (IMPACT OF INCREASING DEMAND OF ENERGY ON ENVIRONMENT)

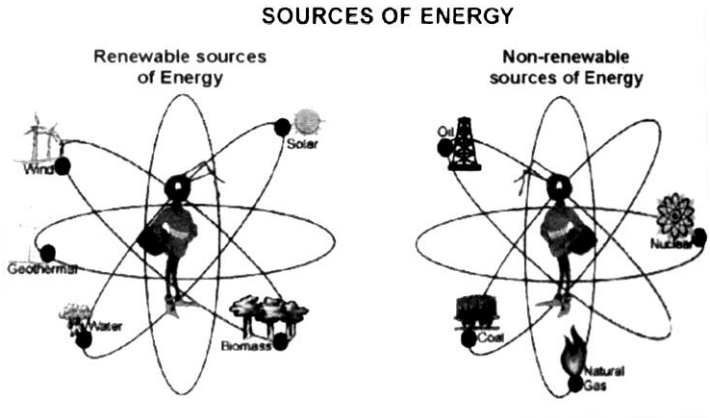
Modem life style of people and dependence on machines operated with energy in the form of heat and electricity for our day to day work has increased the demand for more energy. Consequently, the pace or speed of exploiting more and more sources of energy has been increased. More use of fossil fuels for fulfilling the demand for more energy is polluting air around us. Air pollution is a great danger to the living livings. Although some of fuels like LPG and CNG are considered as clean fuels but extraction and transportation of these fuels cause environmental pollution. At present, our focus has been diverted to extract energy from non-conventional sources of energy like the wind, the sea and the sun to conserve conventional sources of energy. The energy obtained from non-conventional sources of energy is pollution free. But the manufacturing of the devices to extract the energy from fm-conventional sources poses a great threat to the environment. Global warning is another problem, we are facing because of the increased use of energy from fossil fuels. Thus, we conclude that the increasing demand of energy is disturbing the ecological balance.

HOW LONG WILL AN ENERGY SOURCE LAST ?

We have discussed a large number of sources of energy like fossil fuels bio-mass, hydro power, the sun, the wind, geothermal energy, nuclear energy etc. These sources of energy are divided into two categories.

(i) Renewable sources of energy or in exhaustible sources of energy.

(ii) Non-renewable sources of energy or exhaustible sources of energy.



Renewable Sources of Energy

The sources of energy which are inexhaustible (i.e. which can never be finished) and are being continuously supplied by nature are known as renewable sources of energy.

For example : (i) Wind (ii) Hydro Power (iii) The sun (iv) Ocean Tidals Energy (v) Interior of the Earth (vi) Biogas (vii) Plants, vegetable waste etc.

These sources of energy are also known as non-conventional sources of energy.

Non-Renewable Sources of Energy

The sources of energy which are exhaustible (i.e. which can be finished) and have been formed in nature long ago are know as non-renewable sources of energy.

For example : (i) Coal (ii) Petroleum (iii) Natural Gas (iv) Fissionable materials like Uranium.

These sources of energy are also known as conventional sources of energy.

Non-renewable sources of energy like coal, petroleum and natural gas have a huge deposit under the earth. However, the continuous extraction of these sources for the purpose of usable energy is a matter of concern and worry because ultimately the deposit of these sources will be completely finished. It may be noted that the formation of fossil fuels take very long period. Therefore, we should use these fuels judiciously so that their deposit may last long.

On the other hand, renewable sources of energy will last forever. For example, it is estimated that the sun would continue to shine for another billion years. Therefore, the sun as the source of energy will be available for a very long period of time. Similarly, bio-mass as the source of energy will be available for a longer period of time if we grow more and more plants. The wind energy will be at our disposal as long as the sun exists. Geo–thermal energy is another source which will be available for ever.

ADDITIONAL TOPIC

Green house effect

A glass has a special property of allowing infra-red radiation of shorter wavelengths to pass through it. But the glass does not allow the infra-red radiation of longer wavelengths to pass through it. A very hot body like the sun emits infra-red radiation of shorter wavelength. While a body at low temperature emits infra-red radiation of long wavelengths $\left(\lambda \propto \frac{1}{T}\right)$. This property of glass has been used by man in constructing glass houses to protect the plants from the severe cold.

Infra-red radiation emitted by the sun have 8hort wavelengths. These heat radiation pass easily through the window panes and roofs of the glass house. The objects like plants inside the house absorb these heat radiation. Thus, the temperature of the air inside the glass house increases by conduction and convection. The warm objects like plants inside the glass house also radiate energy in the form of infra-red radiation of longer wavelengths. These infra-red radiation of longer wavelength inside the house are not allowed by the glass to escape. Hence, the interior of the glass house and the plants placed inside it remain warm. This is known as Green House effect.

Examples of Green House effect

1. The interior of a car parked in sunshine with its windows closed becomes very hot due to green house effect.
2. Rooms of a house in cold countries whose windows are closed and sunlight falls on them become warm due to green house effect.
3. Solar cookers and solar furnaces are heated due to green house effect.

The Atmosphere of the Earth is a huge Green House

The atmosphere of the earth acts as a green house. The water vapours and carbon-dioxide in the atmosphere are good absorbers of infra-red radiation of longer wavelengths than that of the infra-red radiation of shorter wavelengths. The solar radiation (visible rays, infra-red radiation of shorter

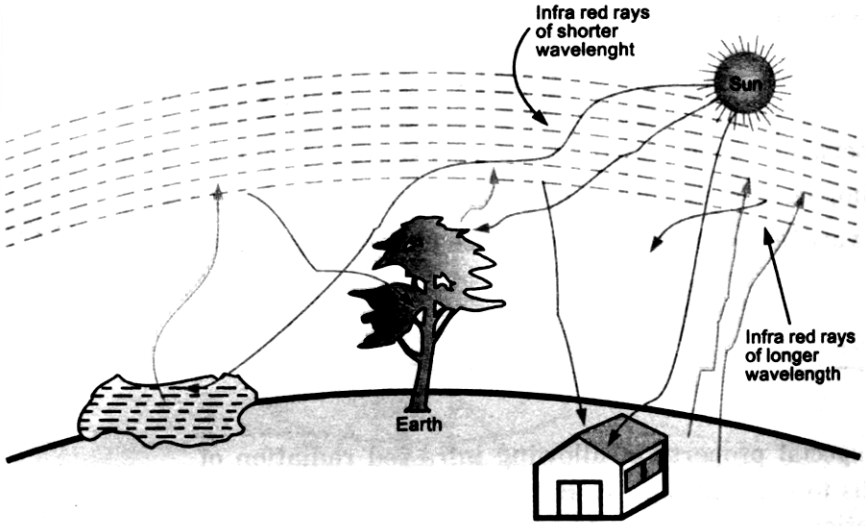


FIGURE 14

wavelength and ultraviolet radiation) pass easily through the atmosphere. The heat radiation passing through the atmosphere are absorbed by the earth's surface and various objects like plants, water and rocks. Thus, the temperature of air and the earth's surface increases. The earth's surface and various objects on it emit infra-red radiation (,i.e., heat radiation) of longer wavelengths. These infra-red radiation of longer wavelengths are absorbed by the water vapours and carbon-dioxide in the atmosphere. Due to these absorbed heat radiation, the warning of the earth's atmosphere take place (Figure 14). The warming of earth's atmosphere due to the trapping of heat radiation (i.e., infra-red radiation) is known as green house effect.

The End

MODEL NUMERICALS

1. If solar constant is $=1{\cdot}4\,kW/m^2$, calculate the solar energy received by 1 m^2 area in one hour.

Solution. Here Solar constant $=1{\cdot}4\,kW/m^2$

Since Watt (W) = joule/sec (J/a)

$\therefore$ Solar constant $=1{\cdot}4\,kJ/s\,m^2$

It means, energy received by 1 m^2 area in $1s=1{\cdot}4\,kJ$

Given, time $=1h=60\times60=3600\,s$

$\therefore$ Energy received by $1m^2$ area in $3600\,s=1{\cdot}4\,kJ\times3600=5040\,kJ$

2. The solar constant at a place is $1{\cdot}4\,kW/m^2$. How much solar energy will be received at this place per second over an area of $5m^2$. (C.B.S.E. 2004)

Solution. Here, solar constant $=1{\cdot}4\,kW/m^2=1{\cdot}4\,kJ/s\,m^2$

This means energy received per second by $1m^2$ area $=1{\cdot}4\,kJ/s$

$\therefore$ Energy received per second over an area of $5m^2=1{\cdot}4\times5$

$=7{\cdot}0\,kJ/s=7{\cdot}0\,kW$

UNSOLVED NUMERICALS FOR PRACTICE

1. The solar constant at a place is $1{\cdot}4\,kW/m^2$. Calculate the solar energy received by an area of $10\,m^2$ in 5 second. **[Ans.** $7\times10^4\,J$ **]**

2. Find the solar energy received by area of $100\,m^2$ in 2 hours if solar constant is $1{\cdot}4\,kW/m^2$.

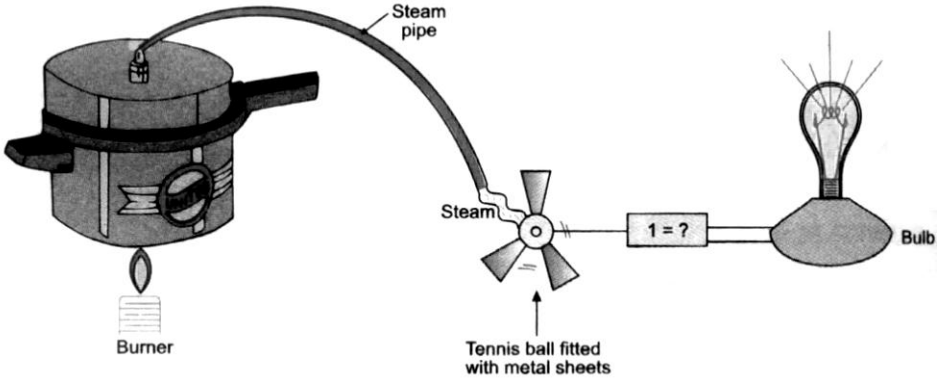
[Ans. $100{\cdot}8\times10^7\,J$ **]**

TEST ASSIGNMENT 1

1. What are the characteristics of a good source of energy ?
2. What is a good fuel ?
3. What are conventional sources of energy ?
4. Give examples of conventional sources of energy.
5. What is hydro electric power ?
6. State two advantages of constructing a dam on a river.
7. State disadvantages of constructing a dam on a river.
8. What is a biogas ?
9. Give an example of a bio-mass energy source.
10. Name the chief constituent of a biogas.
11. Name two main combustible components of biogas.
12. What characteristics should be possessed by the fuel to be used in space rockets ? Given an example of such fuel.
13. Name the kind of energy possessed by wind.
14. Name a part of India where energy is commercially harnessed.
15. Name the country known as the ''country of winds''.
16. What is the need of non-conventional sources of energy ?
17. Define solar constant.
18. Name few device used to harness solar energy.
19. Why is the interior of a solar cooker black ?
20. Write two advantages of solar devices.
21. Define nuclear fission. Give one example.
22. Describe a nuclear chain reaction with an example.
23. What are the disadvantages of nuclear fission energy over the fossil fuel energy ?
24. Define nuclear fusion.
25. Distinguish between conventional and non-conventional sources of energy.
26. What is the impact of increasing demand of energy on environment ?
27. Describe the various steps to be taken to use energy effectively.

HIGHER ORDER THINKING

1. Following model demonstrates the process of thermo-electric production.



(i) Identify and label the device marked as 1.
(ii) Why is tennis bal) fitted with metal sheets rotated ?
(iii) Name the device, which depends on the principle demonstrated by this model.
(iv) Which form of energy is converted into electrical energy ?

Ans. Device 1 is a dynamo.
(i) Tennis ball fitted with metal sheets rotates due to the force exerted on it by the steam.
(ii) Thermal power plant works on the principle demonstrated by the given model,
(iii) Mechanical energy of tennis ball fitted with metal sheets is converted into electrical energy.

2. Give reasons to explain why is it not possible to use solar cells to meet all our energy needs?

Or

Solar cell panels used in satellites to supply energy cannot be used to meet our domestic needs electricity. Explain, why ?

Ans. Refer limitations of Article booklet

3. Solar energy is falling on the surface of a concentrator type solar heater at the rate of $0{\cdot}4\,kW/m^2$. If the surface area of the heater is 5 m² and it reflects only 80% of the total solar energy falling on it to its focus, calculate the energy concentrated on the focus of the heater in 2 hours.

Ans. Rate at which solar energy w falling on the surface of heater $0{\cdot}4\,kW/m^2$

$= 0{\cdot}4\,kJ/s\,m^2 \qquad (\because 1W = 1J/s)$

It means, energy falling on lm² area of the surface of heater in 1 second $= 0{\cdot}4\,kJ$

As, the surface area of heater $= 5\,m^2$

$\therefore$ Energy falling on 5 m² area of the surface of heater in 1 second $= 0{\cdot}4 \times 5\,kJ = 2\,kJ.$

Since, the surface of heater is reflecting only 80% of the total solar energy falling on the surface of the heater to be focussed at the focus of the heater, therefore, the solar energy concentrating on the focus of the heater in 1 second = 80% of 2 kJ

$= \frac{80}{100} \times 2\,kJ = 1{\cdot}6\,kJ$

$\therefore$ Solar energy concentrated on the focus of the heater in 2 hours $= 2 \times 60 \times 60$ second

$= 1{\cdot}6 \times 2 \times 60 \times 60\,kJ = 11520\,kJ$

4. A student constructed a box type solar cooker. He found that it did not work efficiently. What could this be due to ? Give any four possible mistakes in the solar construction and operation of the cooker. What maximum temperature can ordinarily be reached inside a solar cooker ?

(A.I.C.B.S.Ê. 1999)

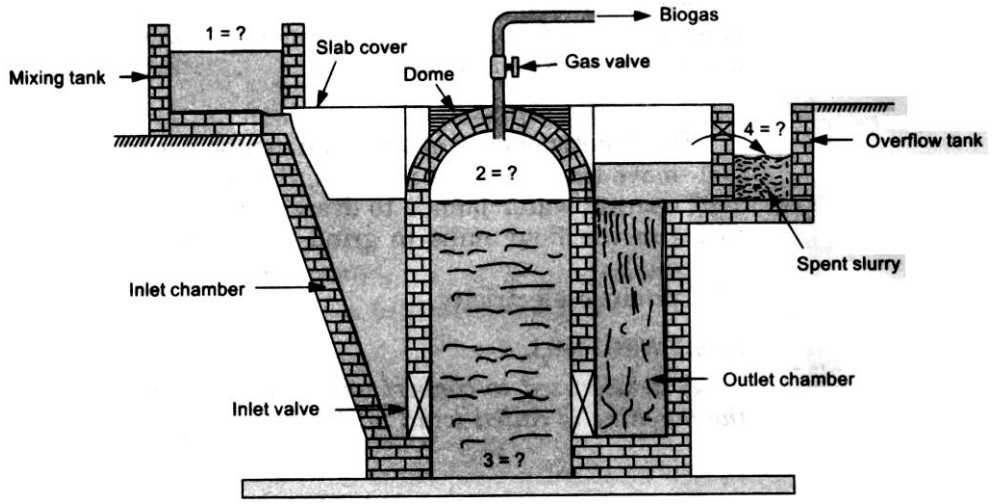
Ans. He might be committing the following mistakes :
(i) He might have not blackened the interior of the solar cooker.
(ii) He might be using a plastic cover instead of a glass cover.
(iii) He might have not made it insulated.
(iv) He might have not used black containers.

Maximum temperature attained in a solar cooker is about 140^oC.

5. A student has set up a solar cooker in a box by using a black painted aluminium sheet, a black cooking vessel, some glass wool, a glass sheet and a mirror plate. What is the role of each it item used in the solar cooker ?

Ans. Black painted aluminium sheet absorbs heat radiation
Black cooking vessel also absorbs heat radiation to cook food.
Glass wool prevents the loss of heat.
Glass sheet prevents the escape of heat radiation from the box.
Mirror plate reflects the sunlight to fall on the glass sheet.

6. A diagram shown below is a biogas plant.



(i) Identify the parts indicated by question marks and labelled 1, 2, 3 and 4 in the diagram.
(ii) Name the micro organisms responsible for the fermentation of the slurry in the digester.
(iii) Name two chemical elements present in the manure or spent slurry.

Ans. (i) (1) Slurry of cattle dung and water
(2) Gas tank containing bio-gas.
(3) Digester.
(4) Spent slurry or manure
(ii) Anaerobic micro organisms.
(iii) Nitrogen and phosphorous are present in the manure.

VERY SHORT ANSWER TYPE QUESTIONS

1. Name the two forms of energy usually used at our homes.

Ans. Heat and electricity.

2. Name two gases, other than carbon-dioxide, that are given out during burning of fossil fuel and contribute towards acid rain formation. (C.B.S.E. Sample Paper)

Ans. (i) Sulphur dioxide (ii) Nitrogen dioxide.

3. Name two renewable or non conventional sources of energy.

Ans. (i) The sun, (ii) The wind.

4. Name two non-renewable or conventional sources of energy.

Ans. (i) Coal, (ii) Petroleum.

5. Define solar constant.

Ans. It is defined as the energy received from the sun in one second by unit square metre area of the earth's atmosphere exposed perpendicularly to the radiation of the sun at an average distance between the earth and the sun.

6. Write the *value* of solar constant.

Ans. Solar constant = 1.4 kWm^{-2}

7. Name two activities in our daily life in which solar energy is used.

Ans. (i) For cooking food using solar cookers. (ii) For drying clothes and food grains.

8. Name the component of sunlight carrying maximum heat.

Ans. Infra-red rays.

9. Name the. component of sunlight that is absorbed by ozone layer of the atmosphere.

Ans. Ultra-violet rays.

10. Which surface absorbs more heat-black or white surface ?

Ans. Black surface absorbs more heat than the white surface.

11. Name the device which directly converts solar energy into electric energy. (C.B.S.E. (Delhi) 1998))

Ans. Solar cell.

12. What is the range of temperature attained inside a box type solar cooker when placed in the sun for two to three hours ? (C.B.S.E. (Delhi) 2001 (c))

Ans. From 100°C to 140°C.

13. A solar cell transforms energy of one form into another form. What are these two forms of energy ? (CS.S.E. (Delhi) 1995)

Ans. Solar energy (sunlight) to electrical energy.

14. *State one* limitation of solar energy availa*ble* from solar cells. (C.B.S.E. (All India) 2007)

Ans. These cells do not operate during night and on a cloudy day.

15. *What is the main basic cause for winds to blow ?* (C.B.S.E. *2*004)

An*s*. The pressure of a region where maximum sunlight falls decreases as compared to the region where minimum sunlight falls. The air moves from a region of high pressure (i.e., cold region) to the region of low pressure (i.e.. hot region). This moving air is the wind.

16. What is the minimum wind velocity required to obtain useful energy with a wind mill ? (C.B.S.E. 2007)

Ans. 15 km/h.

17. What is a wind farm ?

Ans. The region where large number of wind mills are erected to produce electricity is called wind farm.

18. Name the kind of energy possessed by wind. (A.I.C.B.S.E. 1992 (c))

An*s*. Kinetic energy.

19. Name a part of India where wind energy is commercially harnessed. (C.B.S.E. 2004)

Ans. Kanyakumari in Tamil Nadu.

20. Name the trailing country for exploitation of wind energy.

Ans. Denmark.

21. Name the factor which enables the ocean *to a*ct as a store h*ouse o*f energy.
(*C.*B*.S.E. *(Delhi)* 1999 *(c)

Ans. The high value of specific heat capacity of water enables the ocean to act as a store house of heat energy.

22. What is *a biogas ?* (C.B.S.E. (All India) 2006 (c)

Ans. Biogas is a mixture of four gases namely methane, carbon dioxide, hydrogen and hydrogen sulphide.

23. Name the main constituent of a *b*iogas.

Ans. Methane gas.

24. *Name two* main combustible components of biogas. **(C.*B*.S.*E*. (Foreign) 2004)**

Ans. Methane gas and hydrogen gas.

25. What *is* fossil fu*e*l.

Ans. The combustible substance formed from the dead remains of the animals and plants which were buried deep under the surface of the earth over millions of years is called fossil fuel.

26. *Give two* examples of fossil fuels.

Ans. Coal and petroleum.

27. Justify in one sentence that hydropoiver (*hidel* electricity) is a renewable source of energy.
(C.B.S.E. Sample Paper)

Ans. Since hydropower is derived from the renewable source of energy i.e; sun, so it is also a renewable source of energy.

28. What is *nuclear* energy *?*

Ans. The energy which is obtained from the conversion of nuclear mass is called nuclear energy.

29. Is nuclear energy derived from from the sun like other forms of energy

Ans. No. The sun is not the source of nuclear energy.

30. What is a line/ear fission *?*

Ans. The process of splitting of a heavy nucleus into lighter nuclei is known as nuclear fission.

31. Which process is carried out at a higher temperature ? Nuclear fission or nuclear fusion '
(A.I.C.B.S.E. 1994)

Ans. Nuclear fusion.

32. The mass number of three elements A, B and C are 2, 180 and 23S. Which one of them is suitable to make n hydrogen bomb ? (A.I.C.B.S.E. 1995 (c)

Ans. Hydrogen bomb is based on nuclear fusion reaction which occurs due to the fusion of light elements. So element A is suitable to make a hydrogen bomb.

33. What is a fusion reaction ?

Ans. The process by which two or more light nuclei fuse together (or combine) to form a heavy nucleus along with the release of energy is called fusion reaction.

SHORT ANSWER TYPE QUESTIONS

1. Why is the use of wood as a fuel not advised although forests can be replenished ?
(C.B.S.E. (All India) 2006)

Or

The use of dry wood as domestic fuel is not considered ns good. State two reasons for it.
(C.B.S.E. (Delhi) 2004 (S))

Ans. This is because

(i) Deforestation (i.e., cutting of trees in large number) causes many problems like floods, erosion of fertile land and environmental imbalance.

(ii) Replenishment of forests takes long time and as such wood cannot be available to supply continuous energy. '

2. Name the device used to convert (i) Solar energy into heat and (ii) Solar energy into electricity. (b) Explain the working of a wind will. (C.B.S.E. (All India) 2006 (C)

Ans. (a) (i) Solar cooker (ii) Solar cell.

(b) When wind blows with a minimum of 15 km/h, the kinetic energy of the wind is used to rotate the blades of wind mill. The rotational energy of the blades is used to rotate the armature of the generator to produce electricity.

3. On what principle does a solar water heater operate? (C.B.S.E. 2004)

Ans. A black surface absorbs more heat from the sunlight. This absorbed heat is used to heat the water in a solar water heater.

4. Mention any two uses of wind energy. (C.B.S.E. (Delhi) 1997 (c))

Ans. Wind energy is used to (i) operate water pumps to draw underground water, (ii) produce electricity.

5. State two limitations of a wind mill. (A.I.C.B.S.E. 1992 (c) ; C.B.S.E. (Delhi) 2005 (c)

Ans. Refer Article booklet

6. Give (i) two limitations and (ii) two advantages of wind mill. (CB.S.E (Delhi) 2000)

Ans. Refer Article booklet

7. Name three forms in which energy from ocean is made available for use. What are OTEC power plants ? How do they (C.B.S.E (Delhi) 2005)

Ans. (i) Tidal energy, (ii) Ocean waves energy (iii) Ocean thermal energy. OTEC power plants are ocean Thermal Energy conversion plants. For the operation of OTEC, Refer Articles 5.08.

8. "Wind energy, farms can be set up only at specific locations and not every where". Explain why ?

Ans. Wind energy farms are set up to produce electricity on large scale. They are always set up in high wind energy regions where wind blows almost whole of the day so that the generators attached to wind mill work throughout the day. In these regions, wind blows with speed more than 15 km/h.

9. Charcoal is a better fuel than wood. Explain why ?

Ans. It is because (i) charcoal burns easily as compared to wood, (ii) charcoal does not produce smoke on burning and hence it causes no air pollution and (iii) the amount of heat produced by the burning charcoal is much more than the heat produced by the burning wood.

10. Write any four advantages of hydroelectric power. (C.B.S.E. (Delhi) 2006)

Ans. Refer Article booklet

11. (i) Name four gases commonly present in biogas.
(ii) List two advantages of using biogas over fossil fuels. (C.B.S.E. (All India) 2006)

Ans. (i) Methane, CO_2 , hydrogen, Hydrogen (ii) Refer Article 5.05.2.

12. Give advantages of a *biogas* as fuel.

Ans. Refer Article booklet

13. *Why* is biogas a better fuel than animal dung cakes ? (C.B.S.E. (All India) 2005)

Ans. This is because, biogas does not produce smoke during burning and hence there is no air pollution. On the other hand, burning of animal dung cakes causes air pollution. Moreover, biogas gives more heat energy than the animal dung cakes.

14. What is biogas ? How can biogas be obtained ? Why is the use of biogas obtained from cow-dung advised in preference to burning *off' it*'-dung cakes ? (C.B.S.E. (All India) 2006

Ans. Biogas is a mixture of four gases namely methane, carbon dioxide, hydrogen and hydrogen sulphide. Biogas is obtained from anaerobic decomposition of cow dung in a biogas plants. For the use of biogas. Refer booklet

***15*. What is geothermal energy ? What are its advantages ? (C.B.S.E. (Delhi) 2001**

Ans. The heat energy stored in the hot spots of the earth's crust is called geo-thermal energy. For advantages. Refer Article booklet

16. (a) Why is the solar cooker box covered with a plane glass *plate?*

(b)Why is energy of water flowing in a river considered to be an indirect form of solar *energy?*

(c)Write one advantage of nuclear fission reaction. (C.B.S.E. (Delhi) 2007)

Ans. (a) Plane glass plate does not allow the infrared or heat radiation entered in the box to go out side the box. Thus, the box becomes hot. The phenomenon is known as green house effect,

(b) Solar energy evaporates water in rivers, lakes and oceans. These water *vapors* are converted into clouds (K.E. + P.E.). The clouds give rise to rain and hence water flows in rivers. Thus, energy of flowing water in the form of kinetic energy is the indirect form of solar energy.

(c) Nuclear fission reaction gives rise to energy which is pollution-free.

17. Why are fossil fuels known *as* a non-renewable sources of energy ?

Ans. Fossil fuels like coal, petroleum and natural gases take millions of years for their formation. If these fuels are exhausted today, then they may not be formed again. Hence, they are known as non-renewable sources of energy.

18. The production cost of hydroelectricity is cheaper than the electricity produced in a thermal power station. Explain, why ?

Ans. In a thermal power station, coal is burnt to produce electricity, whereas hydroelectricity is produced by allowing the water to fall on turbines. Water in rivers is available free of cost but the cost of extracting and transporting the coal is very high.

19. Out of two solar *cooker's, one* was covered by a plane glass slab and the other was left open. Which of the two solar cookers will be more efficient and why ? (C.B.S.E. Sample Paper)

Ans. A solar cooker covered by a plane glass slab will be more efficient. This is because glass slab does not allow the heat radiation to escape from the solar cooker and hence ' the temperature of the solar cooker covered with glass slab increases more than the temperature of the solar cooker which is left open.

20. Why are *many* thermal power plants set up near coal or oil fields ?

(C.B.S.E. Sample Paper)

Ans. In a thermal power plants, fuel like coal or oil is used in large quantity to produce electricity. These plants are usually set up near coal or oil fields so that the fuel is easily available and the problem of air pollution while transporting the fuel may be minimised.

In Text Questions

1. What is good source of energy ?

Ans. Refer article booklet

2. What is good fuel ?

Ans. A fuel which provides large amount of heat energy without causing pollution.

3. If you could use any source of energy for heating your food. which one would you use and why?

Ans. We would use microwave oven for heating our food. This is because the nutritional value of food is not lost when heated in a microwave oven.

4. What are the disadvantages of fossil fuels ?

Ans. (i) They cause environmental pollution. (ii) They cause global warming. (iii) They do not supply enough heat energy. (iv) The by-products of burning fuels cause acid rain which pollute water resources.

5. Why are we looking at alternate sources of energy ?

Ans. Because the conventional sources of energy may completely be exhausted one day if their use at the present rate continues.

6. How has the traditional use of wind energy and water been modified for our convenience ?

Ans. These energies have been converted into electrical energy using electric generators.

7. What kind of mirror—concave, convex or plane would he best suited for the use in a solar cooker. Why?

Ans. Concave mirror, because it focuses the sun rays at a point to raise the temperature at that point.

8. What are the limitations of the energy that can he obtained from oceans ?

Ans. (i) Energy from oceans is available only when high tides are in the ocean.
(ii) Power plants used to convert ocean energy into electric energy do not operate continuously.

9. What is geothermal energy ?

Ans. The heat energy stored in the hot spots of the earth's crust is called geothermal energy.

10. *What are the* advantages *of* nuclear energy ?

Ans. (i) A small quantity of nuclear fuel gives a large amount of energy.
(ii) In a nuclear power plant, the nuclear fuel is inserted once to get energy over a long period of time.

11. Can any source *of* energy he pollution free ? Why or why *not ?*

Ans. No source of energy is there which is pollution free. However, some sources of energy cause more pollution and some sources of energy cause less pollution.

12. *Hydrogen has been used as a rocket fuel. Would you consider* it a cleaner fuel than *CNG* ? Why or why *or why not ?*

Ans. Hydrogen causes less air pollution than C.N.G. because burning of hydrogen produces water *vapors* and burning of CNG produces CO_2

13. Name two energy sources that you would consider to be renewable. Give reasons for your choices.

Ans. (i) Bio-mass is considered as a renewable source of energy because forests can be replenished.
(ii) Water is also a renewable source of energy as water is continuously available to use due to water cycle in nature.

14. Give the names of two energy sources that you would consider to be exhaustible. Give reasons or your choices.

Ans. (i) Coal (ii) Petroleum.

They will be exhaustible when continuously extracted. Moreover, the formation of these fuels under the earth takes a longer period of time.

CHAPTER END EXERCISES

1. A solar healer cannot be used to get hot water on
(a) a sunny day (b) a cloudy day (c) a hot day (d) a windy day.

Ans. (*b*)

2. Which of the following is not a example of a bio-mass energy source ?
(a) wood (b) *a cloudy day* (c) fossil fuels (d) *a windy day.*

Ans. (c)

3. Most of the sources of energy we use represent stored solar energy. Which of the *following* is *not ultimately* derived from the Sun's energy ?
(a) geothermal energy (b) wind energy *(c)* fossil fuels (d) bio-mass.

Ans. (a).

4. Compare and contrast fossil fuels and the Sun as a source of energy.

Ans. (i) Energy of fossil fuels comes from the solar energy. However, fossils fuels are the non-renewable sources of energy. On the other hand, sun is a renewable source of energy,
(ii) Fossil fuels cause pollution but solar energy does not cause pollution.
(iii) Energy is supplied by fossil fuels at any time of the day but sun supplies energy only when it shines.

5. Compare and contr*ast bio-mass and hydro-electricity as source of energy.*

Ans.

Bio-mass	**Hydro electricity**
(i) The energy supplied by the burning of bio-mass causes pollution.	(i) Hydro-electricity does not cause pollution.
(ii) The energy from bio-mass can be obtained by burning it directly or by a go bar gas plant.	(ii) Hydro-electricity can be obtained by constructing costly dams.

6. What are the limitations of extracting energy from
(a) the wind (b) Waves (c) Tides ?

Ans. (a) (i) We cannot depend upon wind energy as it is available only when strong wind blows. The appliances or machines operating with wind energy stop working as soon as wind stops. The minimum speed of wind to operate generator to produce electricity is 15 km/h.
(ii) Wind energy is not sufficient to operate heavy machines
(iii) The use of wind energy is limited to certain places where strong
(b) Energy of waves can be extracted only if strong winds blow all the time across the sea.
(c) Tidal power plant can extract energy from the waves only when the difference between the water levels of high tide and low tide is very large.

7. On what basis you classify energy source as
(a) Renewable and non-renewable ?

(b) Exhaustible mid inexhaustible ?

Are the options given in (a) and (b) the same ?

Ans. (a) Renewable Sources of Energy are those which are continuously supplied by nature. For example, the sun. the wind.

(b) Non-Renewable Sources of Energy are those which have been formed in nature long ago under certain conditions of temperature and pressure. Non-renewable sources of energy take longer period of time for their formation. For example, fossil fuels like coal. petroleum.

(c) Inexhaustible Sources of Energy are those which supply continuous energy for unlimited time. In fact, exhaustible sources of energy are also termed as non-renewable energy sources. But wood is an exception as it can be made renewable by growing more plants. Inexhaustible sources of energy are termed as renewale sources of energy.

8. What are qualities of an ideal source of energy ?

Ans. (i) It supplies useful energy continuously.

(ii) It does not cause environment pollution.

(iii) It is economical.

9. What are the advantages and disadvantages of using a solar cooker ? Are there places where solar cookers would have limited utility ?

Ans. Advantages

(i) There is no cost of cooking food in a solar cooker.

(ii) No pollution is caused when food is cooked in a solar cooker.

(iii) Nutrition value of food is preserved when food is cooked in the solar cooker.

(iv) Two or three dishes can be cooked at a time.

Disadvantages

(i) Food cannot be cooked at night and on a cloudy day.

(ii) The cost of making solar cooker is high.

(iii) Food cannot be cooked quickly.

(iv) Large quantity of food cannot be cooked with a solar cooker.

(v) Chapatis cannot be made with solar cooker.

Solar cooker will have limited utility at places where the sun shines for shorter period of time or where the sun rays never reach.

10. What are the environmental consequences of the increasing demand for energy ? What steps would you suggest to reduce energy consumption ?

Ans. (i) More use of fossil fuels for fulfilling the increasing demand for energy is polluting air the environment.

(ii) LPG and CNG are considered as clean fuels but the extraction and transportation of these fuels cause environmental pollution.

(iii) The use of large number of sources of energy is causing global warming.

Suggestions

(i) A burning fuel must be extinguished as soon as their use is over.

(ii) Bulbs, tubes and other electrical appliances must be switched off as soon as you leave your room.

(iii) The engines of the vehicles must be switched off when these vehicles are stopped for more than a minute to save fuel.

MULTIPLE CHOICE QUESTIONS

Choose the correct answer in the following questions

1. The radiation carrying heat energy is

(a) visible light (b) infra-red radiation (c) ultraviolet radiation (d) micro-wave.

2 Radiation which are harmful to the living organisms are :

(a) infra-red radiation (b) ultraviolet radiation
(c) visible radiation (d) micro waves

3. A solar water heater cannot be used to get hot water on

(a) a hot day (b) a sunny day (c) a windy day (d) a cloudy day.

4. The radiation in the sunlight that gives the feeling of hotness is

(a) visible (b) infra-red (c) red (d) ultra-violet.

5. Solar constant is

(a) 140 Wm^{-2} (b) l-4Wm^{-2} (c) 1-4 kWm^{-2} (d) M; l-4MWm^{-2}

6. Which of the followings is not a bio mass energy source ?

(a) gobar gas (b) coal (c) wood (d) nuclear energy.

7. The energy which is not derived from the sun is

(a) bio-mass (b) fossil fuels (c) hydro-electricity (d) geo-thermal energy.

8. Harmful radiation emitted by the sun are

(a) visible (b) infra-red (c) ultra-violet (d) radio waves.

9. Solar cells are made of

(a) metals (b) insulators (c) semi-conductors (d) None of the these.

10. Minimum speed of wind to operate generator to produce electricity is

(a) $15 ms^{-1}$ (b) $150 ms^{-1}$ (c) $1500 ms^{-1}$ (d) $15000 ms^{-1}$

11. Most of the sources of energy, we use, represent stored solar energy. Which of the following is not ultimately derived from the sun's energy ?

(a) wind energy (b) bio-mass (c) both wind energy and bio-mass (d) nuclear energy.

12. The main constituent of LPG is

(a) methane (b) butane (c) hydrogen (d) None of these.

13. The main constituent of CNG is

(a) butane (b) methane (c) ethane (d) propane.

14. Which of these is not a renewable source of energy ?

(a) The sun (b) natural gas (c) Wind (d) Ocean tidal energy

15. The radiation absorbed by ozone layer are

(a) infra-red (b) Visible (c) ultra-violet (d) gamma rays

16. The radiation emitted by a hot furnance are

(a) ultra-violet (b) infra-red (c) X-rays (d) micro waves.

17. Radiation emitted by the sun and responsible for the cause of skin cancer are

(a) infra red (b) X-rays (c) micro waves (d) ultra-violet.

18. A welder wears coloured glasses to protect his eyes from

(a) the dust particles (b) infra-red radiation
(c) ultra-violet radiation (d) the bacteria.

19. The warming of earth's atmosphere due to the trapping of heat radiation is known as

(a) distillation (b) photo emission
(c) red house effect (d) green house effect.

20. The largest solar funance in the world is located in

(a) USA (b) Francs (c) Netherlands (d) USSR.

21. The main constituent of a biogas is

(a). Hydrogen gas (b) butane gas (c) methane gas (d) None of these.

22. The country ranks first in the world to produce electricity from wind.

(a) India (b) USA (c) Denmark (d) Japan

23. Specific heat capacity of water is

(a) $4.2\,kg^{-1}C^{0-1}$ (b) $42\,J\,kg^{-1}C^{0-1}$ (c) $420\,J\,kg^{-1}C^{0-1}$ (d) $4200\,J\,kg^{-1}C^{0-1}$

24. Which of the following is not the fossil source of energy ?

(a) Cowdug cake (b) CNG (c) Kerosene oil (d) Coal.

25. Which of the following is more environment friendly ?

(a) Burning of coal (b) Burning of fire wood
(c) Burning of charcoal (d) Burning of diesel.

26. Which of the following causes no environment pollution ?

(a) Nuclear fission reactor (b) Thermal power plant
(c) Nuclear fusion reactor (d) None of these

27. Which of the following is not combusting ?

(a) Oxygen (b) Butane (c) Hydrogen (d) Methane

28. The energy released during nuclear fission and nuclear fusion reactions is due to

(a) chemical reaction (b) the conversion of electrical energy

(c) the conversion of gravitational energy (d) the conversion of mass into energy.

29. The reaction taking place in the core of the sun are

(a) nuclear fission (b) chemical reaction (c) nuclear fusion (d) None of these.

30. In nuclear fission reaction,

(a) light nuclei combine to form a heavy nucleus

(b) light nuclei split

(c) heavy nucleus splits into light nuclei

(d) heavy nuclei combine to form of a super-heavy nucleus.

31. Who discovered nuclear fission reaction ?

(a) Oersted (b) Summerfield (c) Bethe (d) Otto Hahn.

32. The place where nuclear power plant is not situated is

(a) Narora (b) Tarapur (c) Kota (d) Bhopal

33. The source of energy of the sun is

(a) Nuclear fission (b) Chemical reaction (c) Nuclear fusion (d) None of these

34. The energy of a thermal neutron is about

(a) 0.25 eV (b) 0.025 eV (c) 0.0025 eV (d) 0.00025 eV

36. Which of these substance is a moderator ?

(a) CO_2 (b) N_2 (c) cadmium (d) graphite

37. 1 eV = ...

(a) $1.6\times10^{-19}\,J$ (b) $1.6\times10^{19}\,J$ (c) $1.6\times10^{-13}\,J$ (c) $1.6\times10^{13}\,J$

38. India exploded her first underground nuclear device at

(a) Ranchi (b) Kota (c) Jaipur (d) Pokhran.

39. Fusion reaction is also known as

(a) chemical reaction (b) elastic scattering

(c) thermonuclear reaction (d) photo nuclear reaction.

Answers

1.(b) 2.(b) 3.(d) 4.(b) 5.(c) 6.(d) 7.(d) 8.(c) 9.(c) 10.(d) 11.(d) 12.(b) 13.(b)
14.(b) 15.(c) 16.(b) 17.(d) 18.(c) 19.(c) 19.(d) 20.(b) 21.(c) 22.(c) 23.(c) 24.(a) 25.(c)
26.(c) 27.(a) 28.(d) 29.(c) 30.(c) 31.(d) 32.(d) 33.(c) 34.(d) 35.(b) 36.(d) 37.(d) 37.(a)